ON THE SEWERAGE OF KANSAS CITY.*

Being a Review of a Paper on the Same Subject by Mr. O. Chanute, C. E.

By Robert Moore, Mem. of the Eng. Club of St. Louis.

[Read March 12, 1884.]

The paper "On the Sewerage of Kansas City," read by Mr. O. Chanute before the Kansas City Academy of Science in November last, and reprinted in Engineering News Feb. 16, 1884, merits some notice on the part of the large class of engineers to whom his conclusions appear unsound and his advice bad. For his widely known ability and well deserved reputation as an engineer are such, that whatever he says will have great weight with the public and with engineers who are not experts in the matters he discusses.

The purport of his advice is: that Kansas City should abandon the construction of sewers for storm water, except in special cases, and instead thereof adopt the separate system of sewerage as "finally perfected" by Col. George E. Waring, Jr., and constructed at Memphis.

The premises upon which this conclusion is based are substantially these:

1. Sewers for storm water are, with exceptions in special cases as already noted, unnecessary, street gutters and other open channels being all that is required.

2. The adoption of the separate system, to which, as he tells us, "the name of Mr. Waring has been justly attached," will involve a large saving of money, the amount for Kansas City being, as he figures it, a little more than one million dollars, or about fifty per cent. of the cost of sewers on the combined system.

3. But, most important of all, the system proposed will in a sanitary view be much the safer, use of storm water sewers for purposes of house drainage, being as compared with separate system, inimical to the public health.

Let us consider each of these propositions.

First, then, is it true that surface channels will be sufficient for the carriage of storm water in a town like Kansas City?

If the experience of other cities can be applied to this one, the answer to this question must be very strongly in the negative. In them the universal experience is that as soon as the city becomes at all crowded or closely built the surface channels for storm water become nuisances which it is necessary to abate by the construction of sewers. And as a rule the first sewers in all large cities were constructed for this purpose and no other. The causes of trouble in this case are several.

1. The cross gutters necessary to carry the water over intersecting streets are serious obstructions to public traffic.

To any one who has watched the effect of these gutters in the unsewered parts of a large city in obstructing the passage of vehicles, or who has ever had charge of sewers and listened to the appeals for street corner inlets to abate the cross gutters a simple mention of the matter is enough. And, in Kansas City, I am told, the City Engineer cannot keep up with this demand for new inlets.

2. The accumulation of water in the gutters during heavy rains and on steep grades, such as prevail in Kansas City, soon becomes destructive and dangerous.

A correspondent there writes me thus:

"Surface water is universally felt to be a nuisance. It runs in torrents down steep streets, scouring out gullies and carrying mud and macadam before it, till it is checked at a break in the grade and spreads into a lake. There it deposits its load, fills up gutters, overflows cellars, and takes a fresh start."

3. Where the grades are flat there is trouble of a different kind. The water then collects in stagnant pools which in warm weather soon become offensive. Examples of this can be found in every city, but I know of none better than in New Orleans, where a large part of the sanitary work necessary in warm weather is the flushing of the gutters.

In the larger and natural channels precisely the same thing takes place. It is found impossible to keep out of them rubbish and refuse matter from factories and stables, and they become polluted. This may happen even if nothing goes into them but the washings from the streets. The analyses of Prof. Way, cited by Baldwin Latham (*Sanitary Engineering*, page 43], show that in London, which is kept cleaner than any American city, the drainage water from the streets in time of rainfall is quite as impure as any sewage.

This pollution of the streams, even in the thinly populated outskirts of cities, is of constant occurrence. Some notable examples of it exist in St. Louis, and, if I am rightly informed, others equally good can be found in Kansas City. The only remedy is to straighten and pave the channel, so that the water will flow off before it has time to become offensive, or, if the stream be not too large, convert it into a sewer.

4. But even if the streams were to remain pure and clean, the time comes, sooner or later, in every city, when the ground which they occupy is needed for other uses.

In London, for example, the old River Fleet first degenerated into the Fleet Ditch, and then became such a "grievous and dangerous nuisance" that it was converted into the Fleet Sewer, over which there now passes the dense traffic of Fleet street. In like manner in St. Louis the old channel of Mill Creek is now the Mill Creek sewer, and is covered over with streets, railroad tracks and buildings. And so in every city, the old streams, unless they are so large as to make it impossible, are arched over and the ground which they occupied converted to purposes of business.

Surface channels may answer well enough, or at least be tolerated, in a small town or sparsely settled village, but for the full development of a city sewers for storm water are as necessary as the paving of its streets, and their construction should enter into the plans of every town that expects to become a city. But Kansas City has already a population estimated at more than 80,000, and is growing at a rate which, if continued, will bring it in 1890 up to 125,000, and in 1900 up to 245,000, with a strong probability that these figures will be exceeded. Clearly this is not a place for any plans but those which are appropriate to a city.

Moreover the steep grades which prevail in Kansas City, ranging as they do in the sewers from two up to twelve feet per hundred, have the effect of very greatly reducing the sizes of the sewers, as compared with what would be needed elsewhere. A sewer of 6.3 feet diameter with a two per cent. grade, or one of 4.4 feet diameter with a twelve per cent. grade, will carry as much water as a sewer ten feet in diameter having the grade of the Mill Creek sewer in St. Louis.

To all this the paper under consideration opposes very little, the surface removal of storm water, except in special cases, being almost taken for granted without argument. The author, however, remarks in one place that in Kansas City "storm water can be quickly and cheaply got rid of by open gutters combined with a few storm sewers" for the reason that "the grades are steep and the slopes short," and "in our climate," he adds, "the rains are needed to wash the streets."

Now, while it is true that the grades are steep, running as high as twelve feet per hundred, the map shows the shortest slope in the direction of the streets, from the crest of the ridge to the river, to be 3,500 feet. But on such grades storm water in the gutters becomes a serious matter after it has run five or six hundred feet. Beyond that distance it becomes a raging torrent, sweeping everything before it and rendering the cross streets for the time being impassible. I should say that a thousand feet, or less than one-third of the shortest slope, was the limit of endurance, leaving the other and lower two-thirds to be in any event provided for by sewers.

The argument that "the rains are needed to wash the streets" has, in this connection, little or no force, inasmuch as the combined system of sewerage still allows the rain to fall on the streets and run into the gutters, thus utilizing it as a cleansing agent as fully as the separate system, but without allowing it to become a source of inconvenience or destruction.

In another place Mr. Chanute says that on account of the great activity in building up and digging down in Kansas City, storm sewers will be obstructed by rubbish, unless they be made "large enough for men to go into them and clean them," as in the French practice.

But even if it were impracticable to exclude rubbish from the sewers by trapping the inlets, as is successfully done elsewhere the world over, the steep grades, to which he has just referred, will not only cause a reduction in the sizes of sewers, as we have already seen, but will also produce a velocity of flow so great that, unless there be some criminal carelessness, the danger of stoppage may safely be neglected.

Assuming, therefore, as I think we must, that storm water sewers will be a necessity, it is certainly cheaper to use them for house drainage than to construct another system for that purpose. So that in place of the saving which Mr. Chanute figures as the result of the policy which he proposes, we may put down a loss ultimately of an amount about equal to the cost of the second system.

Now, of course, if there were any difficulties of sewage disposal in the case, if the sewage had to be pumped or treated by any of the methods of filtration or irrigation, this greater cost might be justified. But nothing of this kind exists or is alleged. Of both systems alike the Missouri River is to be the final and sufficient outlet.

But is there, last of all, any sanitary reason for abandoning the combined system and introducing in place of it the separate system, as is recommended in the paper under discussion? This, of course, is the most important question of all, far outweighing any considerations of cost.

Of Mr. Chanute's convictions on this point his paper leaves us in no doubt. Nearly two years ago, he tells us, when on a visit to Kansas City he learned of the proposed adoption there of the combined system of sewerage. Thinking this would prove to be a mistake, and feeling a great interest in the welfare of the city, he called together a few citizens and the reporters of the public press, and, citing the testimony of other men and the experience of other cities, pointed out "that not only would the combined system be very much more expensive than the separate system," but "would also largely increase what physicans call zymotic diseases" such as typhoid, diphtheria, scarlet fever, etc., a class of diseases from which Kansas City had hitherto been happily remarkably free." Again he says, "The combined system is said by sanitarians to involve grave dangers to public health," whilst, "on the other hand the separate system is free from the slightest taint of suspicion. It is universally admitted to be healthy and safe."

Now, if true, these statements are certainly important. But when we consider that the system which they condemn is almost the only one used in large cities, that its introduction has always been attended with greater sanitary benefit than any other agency, and that it is indorsed as promoting the public health by the ablest and most experienced sanitarians and engineers in the world, such men as Bazalgette and Lindley and Chesbrough, we are bound before accepting these opposing conclusions of Mr. Chanute to demand of him

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nothing less than the most clear and positive proofs. What then has he to offer?

First of all he presents an argument from the nature of the case, to this effect. The house drainage does not fill the large sewers of the combined system more than one-twentieth full. Hence, to use his own words, "the result necessarily must be that during at least nine-tenths of the time the Kansas City sewers will be nineteen-twentieths full of noxious gases, which physicians tell us are dangerous to life."

Now as the gases here spoken of are the results of the ordinary processes of fermentation and decomposition, there can be no difference in the amounts evolved from the same quantity of sewage in different sewers, unless there be a difference in the time of exposure that is in the velocity of the current. But in any given case the two classes of sewers will be of the same length and the same grade, and there will be no difference affecting velocity excepting in the hydraulic radius or mean depth of flow. In the ordinary egg-shaped sewers, however, even this is almost the same, whatever difference there is, being in the vast majority of cases, offset by the greater volume of water admitted to the larger sewer. So that if we compare well-built sewers of the two classes we shall, as a matter of fact, find no material difference in the two cases, either in the velocity of flow or in the quantity of the products of decomposition. But there will be the great difference that these products will in one case be mixed with a volume of air vastly greater than in the other. And as in other cases the dilution of a poison lessens the danger, it certainly seems not unreasonable to believe that, unless some special means be taken to counteract the effect of size, the larger sewer will be the safer. On this point we have some positive evidence which is worthy of consideration.

In 1875 there occurred in Croydon, about eight miles south of London, an epidemic, of enteric, or typhoid fever, in which in a population of 81,000 there were nearly 1,200 cases. The Local Government Board, the central sanitary authority in England, sent Dr. George Buchanan, who has since been promoted to the high position of Chief Medical Officer to the Board, to examine into the causes of this outbreak.

It should here be premised that Croydon had been drained since 1851 by a system of small pipe sewers put in under the auspices of the General Board of Health, who were at that time the champions of this system. After one or two typhoid epidemics, of which the first occurred in the next year after the sewers were completed, a large number of the four and 6 inch mains were taken up and nine-inch pipes substitued. Open grated manholes were put in, in large numbers and three-inch iron ventilating pipes put on to the houses, which were connected with the sewers without any intervening trap after the manner adopted in Memphis by Colonel Waring. In fact nothing was wanted but the flush-tanks of Mr. Rogers Field, not then invented, to make the drainage system identical with that which Col. Waring has since patented. But there were flushing arrangements of a different kind, so that the resemblance to the Waring system was still very close.

The investigation of Dr. Buchanan was of the most thorough kind, and his conclusion, as given in his printed report to the Local Government Board, was that the sewers of Croydon had been the chief agency in propagating the fever. After mentioning other cases of the same kind "in Rugby, in Carlisle, in Chelmsford, in Penzance, in Worthing," all sewered with small pipes, and in the last two of which epidemics had broken out, severe and sudden, "without there being any question of other distribution than through the sewers," he adds: "Towns with larger sewers have not appeared to have the same suddenness of outbreak when spread by means of sewer air. In them the evil influence of sewer infection is more gradually manifested, as might be expected from the different physical circumstances of the two kinds of sewers."

After remarking upon the greater relative displacement of air in small sewers by any sudden increase of flow, he further says: "It is plain that means of ventilation are wanted more numerously in proportion as the displacement of air may be local and sudden. For any want of freedom of current and lack of proper exit-means for displaced air *tells for more* in small than in large sewers." He remarks also upon the great danger, as shown by the experience of Croydon, of connecting houses with the sewers without the intervention of a trap, which is the Memphis plan, and by which the air of the sewers is brought directly into the house, or "laid on," as Dr. Buchanan expresses it, and he recommends a disconnecting trap in all cases, as does nearly every other sanitary engineer with the exception of Col. Waring.

From this testimony then, which is of the very highest order, it appears that the separate system, and particularly Colonel Waring's form of it, is not "universally admitted to be healthy and safe," but is tainted with grave suspicion; that in point of fact it involves greater dangers and requires greater care than does the combined system.

But Mr. Chanute also adduces some testimony which we must for a moment examine. Of this the first item is, that on his return to Kansas City, after the persistent disregard of his advice of two years before and the construction of many miles of the kind of sewers he had condemned, finds, upon inquiry, "a general impression that the city is not as healthy as it was in the early days of its history." Some of the leading physicians have also informed him that "there has been an increase in zymotic diseases, and that they showed a marked difference in type from the same diseases as they existed in the days before sewers." On the other hand he adds, with great fairness, what ought usually to be added in regard to "general impressions" of this sort, "that in few cases only have they been traced directly to the sewers or to defective plumbing. Other physicians again, while admitting an increase in zymotic diseases, attribute it to the increase of population, or to the turning up of the soil while carrying on public improvements in various parts of the city." To all of which I think nothing more need be added. Mr. Chanute himself seems to be of the same opinion, and admits that he "must abstain now from making a positive statement upon this branch of the case."

The next testimony is that of the people of Memphis, who have tried the Waring system for four years, and who, as Mr. Chanute tells us, pronounce it a "complete success," and are "thoroughly satisfied with the result."

Now, as far as it goes, this testimony is certainly valid and to the point, but a consideration of some other facts will, I think, show that it is not much more conclusive than the "general impression" already cited. It might perhaps, be a sufficient reply to place in evidence the experience of the city of St. Louis, which for more than thirty years has tried the combined system, and in which the mortality rate is now 21 as compared with 36 per 1,000 in the decade preceding the construction of sewers, after excluding the cholera year 1849, in which the rate was 106. Of course, it goes without saying that in view of these facts the community is, if possible, more than "thoroughly satisfied with the result."

But as the question is not so much what the people of Memphis or any other city think as what they ought to think, let us for a moment consider the facts of this much cited case.

In the decade 1870 to 1880, Memphis had experienced three epidemics of yellow fever, the first in 1873, the next in 1878, followed by another in 1879, that of 1878 being one of the most terrible in modern history. The highest sanitary authority, the National Board of Health, after a most careful survey of the situtation, had pronounced the immediate and total abandonment and obliteration of the cess-pool system of the city to be one of the essential conditions of its future safety. With a population of but little more than 30,000 [being exactly 30,659 on Jan. 1, 1880, by the National Board of Health census], with its finances in such a hopeless condition that it had sought refuge from its creditors by surrendering its franchise as a city and becoming simply a "taxing district," the question was not what system of sewerage is, in the long run, best for a large city, but what system will abolish the cess-pools of Memphis in the shortest time and for the smallest amount of money. To this question the committee of the National Board of Health, of which Colonel Waring was a member, had answered by recommending the separate system, and under the circumstances its adoption by the city was the only thing possible.

The execution of this plan, having been put into the hands of Colonel Waring, was carried out with much energy, but, in several important respects, the work done there does not commend itself as a precedent. The pipes were laid, as he himself says, with an "utter disregard of alignment" and only six feet deep, so that the drainage of cellars is impossible. The mains were so badly proportioned to their work that some of them run "over full all the time," and several of them must be either enlarged or duplicated. Manholes were almost entirely omitted, although the experience of Memphis since, and of all the world before, has shown them to be necessary, whether on small sewers or large ones. In order to flush the main sewers, a large number of Field's automatic flush tanks, on which Colonel Waring controlled the patent, were put in;* but by the total exclusion of rain water, any flushing of the house drains, where flushing is needed most, is rendered nearly impossible. Then, to, the mode adopted of ventilating the sewers through the house drains is, as we have seen, one which, after trial, has been condemned by Dr. Buchanan, and sanitary engineers generally, as dangerous to the public health.

But, notwithstanding all their defects, the new sewers, with occasional obstructions, have continued to run, the cess-pits have been abolished, and the yellow fever has not come nearer to the city than 300 miles. Let no one, however, jump to the conclusion that Memphis is happy above other cities which are not sewered on the Waring system, for such is not the fact. As the result of a most careful study of the records, Dr. Reilly, Inspector of the National Board of Health, found that in the five years preceding the year 1880, in which the new sewers were constructed, the average death rate of Memphis, excluding mortality from yellow fever, was 34 per 1,000. Since the construction of sewers, we have mortality reports for 1881, 1882 and 1883, in which the total deaths were 1,471, 1,121 and 1,403. Computing the population from the census of June 1, 1880, on the basis of four per cent. increase per annum† (which is the rate used for St. Louis, and is higher than the census figures would

*Since this paper was put in type, I have been informed by Colonel Waring that the regular royalty on the flush tanks was, in this case, largely reduced, and his own share of it wholly remitted to the city. The number of flush tanks in use Jan. 1, 1884, on 39.1 miles of sewers, was 186, or one for every 1,110 feet of sewer.

† The figures used for the population are:

June 1st	1880	33,593—U. S. census.
"	" 1881	34,937
"	" 1882	36,334
"	" 1883	37,787

To bring the average death rate since the construction of sewers down to the former rate of 34 per 1,000 would require us to assume that the population had increased at the wholly improbable rate of eight per cent. per annum, or one which would double the population every nine years.

allow for Memphis), we find the death rates for these years to have been 42.1, 30.9 and 37.1, respectively, or an average rate of 36.7 per 1,000 as against 34 during the preceding five years in Memphis, and 21 during the last four years in St. Louis. Now, without caring to press these figures to the conclusion that the new sewers have been of no benefit to the public health, or in fact to any definite conclusion whatever, it is very clear that they do not tend to show any sanitary superiority of small sewers over large ones, and the advocates of the Memphis system would, I think, do well, for the present, to adopt the words of Mr. Chanute, and "abstain now from making any positive statement upon this branch of the subject."

As a result of this discussion we may, I think, very safely conclude that if sewers for storm water be needed in Kansas City, as they will be if the city continues to grow, there is no sanitary reason for constructing another system for the purposes of house drainage. Or, to use Mr. Chanute's own illustration, if we have cut a hole for the cat we need not make another for the kitten, Colonel Waring to the contrary notwithstanding.

Of course there may, and no doubt will, arise cases where, for special reasons, such as the extension of water pipe into a sparsely peopled district or suburb, a system of small pipe sewers may be the only available means of preserving the soil from saturation with filth. Such cases exist in St. Louis and no doubt exist in every growing city, and the remedy should be promptly applied. But even here the example of Memphis offers more to be avoided than to be imitated. The pipes should always be placed deep enough to drain the cellars. They should be laid in straight lines and provided at the changes of line or grade with properly ventilated manholes or lamp-holes, and should not be connected with the houses except through a trap. The admission or exclusion of rain water should be decided in accordance with the circumstances of each case. If it can possibly be disposed of by overflows or otherwise, the admission of roof water is of very great advantage to the house drains. As regards flushing the main sewers, it is more than probable that with the steep grades and muddy water of Kansas City, a manhole with a flushing gate will be better than any form of automatic flush tank. In fact, the pipes will probably be found, as in like cases in St. Louis, to keep themselves perfectly clean without any artificial flushing whatever.

If is true that systems of this kind, except where they lie at the extreme upper limit of a water shed, will, in the great majority of cases, be in time superseded by the storm-water system, and there will be a loss in money. But nothing will have been spent in royalties, and there will be a saving in that which gives money its only value, the health and life of its possessors.

PERHAPS the finest office building in the world is now being erected at Nassau and Liberty Streets, New York City. It is a mass about 180 feet square, and thirteen stories high. It contains nearly two hundred offices of from one to half a dozen rooms, and the tenants will be favored mortals. The elevators take but one minute to rise to the thirteenth story and their movement cannot be felt when your eyes are closed. From the six or seven upper floors the whole of New York and both rivers are in view. Every office is heated by steam, lighted by incandescent electric lights and furnished with hot and cold water. The top floor is fitted up as a complete hotel, containing a large restaurant, where many of the 1000 inhabitants of the building will take their meals; a reading and writing room, a complete library, with librarian, telegraph office, telephone exchange, and a large number of bedrooms for men detained down town all night—the first building in the city in which this convenience has been offered. A busy man, could live for months in it without going outside. He would have his choice of banks, of insurance companies, of businesses, of restaurants and of bedrooms right there under that one roof.

The Holly-Gaskill Pumping Engines at Saratoga, N. Y.

We reprint from *Engineering* the following description of the Saratoga Pumping Engines designed by Mr. H. H. Gaskill, and constructed by the Holly Manufacturing Co., of Lockport, N. Y, and reproduce also from same journal the accompanying illustrations.

The contract requirements of the engine were a pumping capacity of four million United States gallons in twenty-four hours, working at eighteen revolutions per minute against a pressure of 80 lb. per square inch, and a duty equal to 80,000,000 lb. of water raised 1 ft. high with a consumption of 100 lb. of best coal. Reducing this to the units used in this country, the capacity becomes 3,332,000 gallons, and the duty 89,600,000 foot-pounds per 112 lb. of coal. The duty developed upon the contract trial, according to the report, charging the engine with all coal burned, with no allowance for unburnt coal, ash, or clinker, or water entrained in the steam, was nearly 114,620,800 foot-pounds per 112 lb. of coal. This capital record has been the subject of two interesting reports, one by Mr. John W. Hill, in the October number of Van Nostrand's *Engineering Magazine*, and the other by Mr. Charles T. Porter, published by the Board of Water Commissioners.

Mr. Hill made the first trial referred to above, and Mr. Porter made a second trial about four months later, and obtained even better results, his figures showing a duty of 126,447,980 foot-pounds per 112 lb. of coal. In both cases the work of the pumps was estimated or calculated from the pressure and the displacement of the plungers, a small allowance being made for slip.

There are four steam cylinders, arranged in pairs, a high-pressure cylinder lying horizontally over each low-pressure cylinder, and being connected to it by short direct passages. This arrangement requires the pistons of the two cylinders to move in opposite directions. Each pair of steam pistons drives one pump, the rod of which is connected directly to the crosshead of the low-pressure piston, and by means of a beam and system of short links with the high-pressure piston (see Fig. 1, Page 196).

The low-pressure piston is provided with two rods, which are extended to the length of 10 ft. to the crosshead by which they are connected to the rod of the pump plunger (Fig. 18). Midway in their length another crosshead is secured upon them: this crosshead runs on a guide. The rod from the high-pressure cylinder is keyed into a crosshead (Figs. 10, 11, 12 and 13, corresponding to this, The connection between the two rods is made by a short vertical beam (Figs. 8 and 9) and connecting links. The crankshaft is driven by connecting rods pivoted to the upper end of the vertical beams.

The steam valves are of the double-beat poppet style: the intermediate valves and exhaust valves to the low-pressure cylinders are gridiron slides. The steam valves are adjustable at the will of the engineer, but the intermediate and exhaust valves have a fixed action relative to the motion of the piston. All the valves are driven by eccentrics, mounted upon two longitudinal shafts turning in bearings sprung from the inner sides of the high pressure cylinders. These shafts are driven by mitre wheels from the main shaft.

The pumps are of the double-acting plunger variety, packed with an internal gland which is adjusted by means of bolts passing through the rear pump heads. Each plunger is driven by a single rod (Fig. 1).

The governor is constructed to be operated by changes in the pressure of water in the delivery main, and acts to correct these changes by varying the point of cut-off, and thus the speed of the engine, in accordance with the variations in the demand for water. All the cylinders and their heads are steam-jacketted. The water formed by condensation is returned to the boilers in the following manner: The jackets blow directly into a small heater. The feed-water is conducted through this heater in a 2 in. coil pipe. A separate pump receives its supply from the bottom of this heater, and sends the hot water forward to unite in the feed pipe with the new water, which has been already partially warmed in passing through the coil in the heater. This is a restoration to the boilers of that portion of the heat supplied by them to the jackets which had not been imparted from the jackets to the steam in the cylinders. There is no provision for measuring the amount of steam condensed in the jackets.

The following are the principal dimensions of the engines:

Stroke of all cylinders	36 in.
Diameter high-pressure cylinders	21 "
" " " piston-rods	3 "
" low " cylinders	42 "
" " " piston-rods	3.5 "
Clearance high " cylinder	2.35 p. ct.
" low " "	2.50 "
Diameter of flywheel	12.33 ft.
Weight	12,000 lb.
Diameter of main shaft	10 in.

The pumps are provided with by-pass pipes and valves, forming, when the latter are open, a communication, between the two chambers of each pump. Their function is this: At the instant of starting, the engines are able to exert only a portion of their power, because no steam has yet been admitted to the low-pressure cylinders. The pressure of water is liable to be greater than the steam in the high-pressure cylinders alone can overcome. In such a case, the by-pass valves can be opened, when the water flows through them into the opposite chambers, the pressure on the opposite ends of the plungers is in a measure equalized, and the engine is enabled to start. As soon as it is fairly in motion, these valves are closed. They are available, also, when the motion of the engines required to supply the demand for water would be so slow that on account of the insufficiency of the flywheel, it could not be maintained with the desired regularity, or perhaps not at all. Then, by partially opening these valves, the engines are enabled to run faster, and so to maintain their motion satisfactorily, the excess of water displaced by the plungers passing through them into the chambers that are filling.

The principal dimensions of the pumps are:

	ft.	in.
Aggregate length of the two chambers in each pump	7	6
Width of the two chambers in each pump	2	3
Height of the two chambers in each pump	2	11
Capacity of each pump-chamber, in cubic feet	25	
Diameter of plunger	0	20
" rod	0	4
Area of plunger, mean of two faces	307.88 sq. in.	
Stroke of plunger	36 in.	
Displacement of plunger, in cub. ft.	6.41417	
" in U. S. gallons	48	

In June, 1883, the official trial mentioned above was made to verify its fulfilment of the contract by Mr. Charles T. Porter. The main trial was directed to prove that the stated requirements were satisfied, and after this was completed, the plant was submitted to a "fire pressure test," that is the water pressure was raised to 140 lb. on the square inch, the engine running at eighteen revolutions. The first test occupied from 5 p. m. on June 18 to 1 p. m. on June 21, and the second test was then applied for five hours. As the water was delivered by the pumps direct into the distributing mains its volume could not be measured. The capacity of the pumps was, therefore, found by computation from the displacement of the plungers. The loss by return of water through the valves while closing, technically termed the slip, was assumed to be very small, only a fraction of 1 per cent., as it could not be seen on the diagrams.

The pressure in the supply chambers was got by the indicator, with a spring showing 12 lb. to the inch. The pencil described a figure which afforded an interesting exhibition of the changes in the pressure as momentum was imparted or arrested in the current of water. The mean pressure, when corrected for elevation, was found to be 1¼ lb. on the square inch at the centre of the plungers, showing the level of the water from which the supply is drawn to be about 34 in. above this point.

It was observed, relatively to the fluctuations of pressure, both in the supply chamber and in the delivery main, and also relatively to the motions of the plungers while the valves were closing, that in these pumps this motion, with that of the pistons, is controlled by the cranks, precisely as if it was transmitted through them. The valves were assumed to close only as fast as gravity would cause them to fall, although possibly the reverse current brings them to their seats more quickly than this. But, it is stated in the report that, even on this assumption, the slip was no more than four-tenths of 1 per cent.

The two boilers furnishing steam are of the horizontal return tubular type, the following being the principal dimensions:—

Diameter	66 in.
Length	18 ft.
Number of tubes in each boiler	67
External diameter of tubes	3 in.
Arrangement of tubes: horizontal and vertical rows	
Least distance between tubes and shell of boiler	4.5 in.
Height of crown of boiler above tubes	24 in.

Heating surface in both boilers as follows:—

One half the shell, 311; tubes, 2460 Total	2771 sq. ft.
Furnace, width	6 ft.
Furnace depth	5.75 ft.
" length of opening between grate bars	5 ft.
Furnace, length of these openings uncovered	4.25 ft.
Furnace, width of each grate bar	1.75 in.
" " air spaces	.5 in.
" square feet of grate area, under both boilers	51.00
Furnace, of which the proportion in air space is only	.22

Horizontal flues as follows:

Three times the length of each boiler	54 ft.
From wall between boilers to chimneys	24 "
Total	78 "
Internal diameter of common flue and chimney	3 "
Height of chimney above flue	75 "
Square feet of heating surface for each one square feet of grate area	54.3
Square feet of heating surface for each indicated horse-power	14.9

Mr. Porter reports the following results of a test of forty-eight hours.

Boilers:

Coal burned	16,980 lb.
" per hour, on each one square foot of grate	6.9 lb.

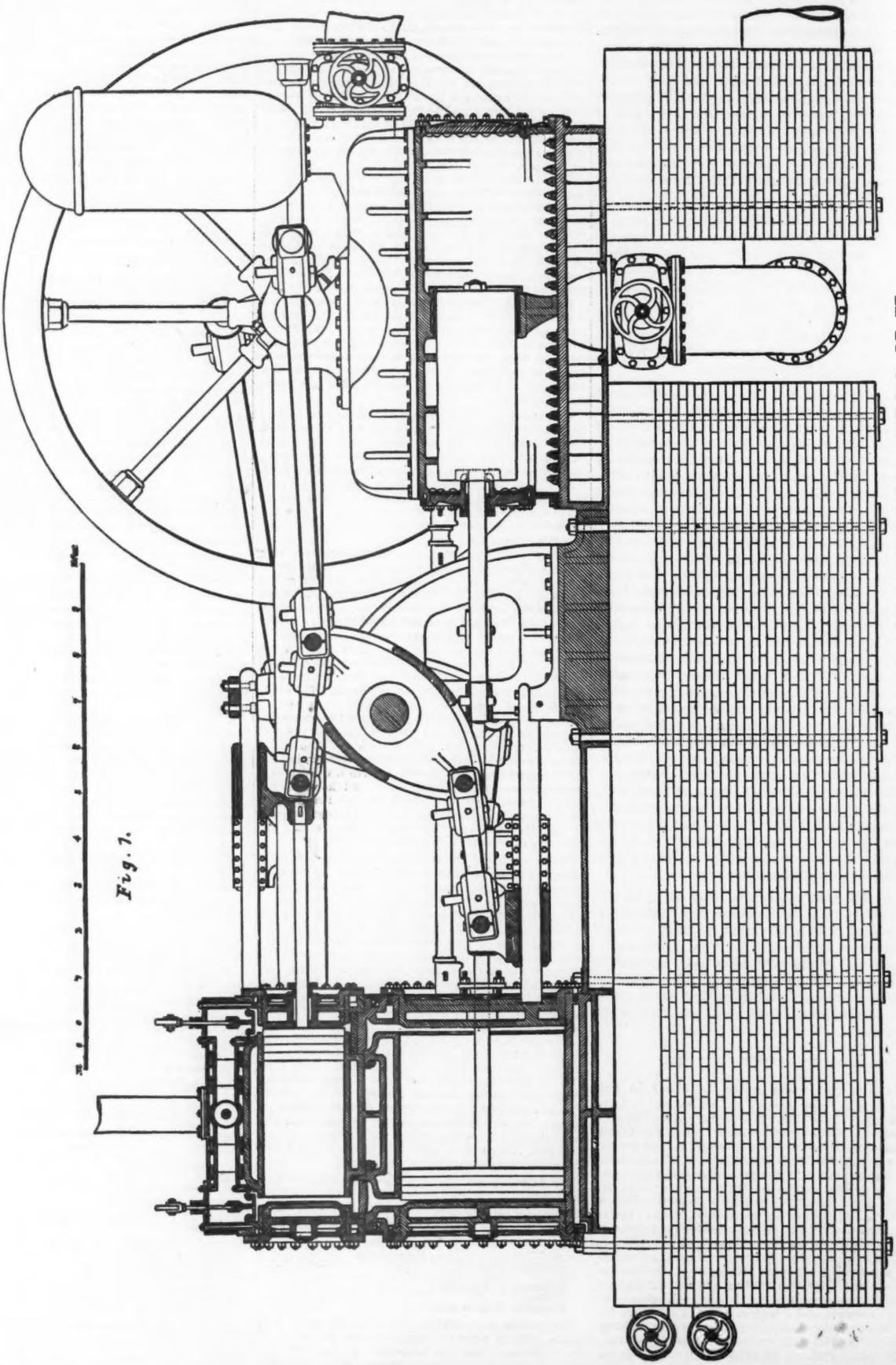

Fig. 1.

DETAILS OF GASKILL PUMPING ENGINE, SARATOGA, N. Y.

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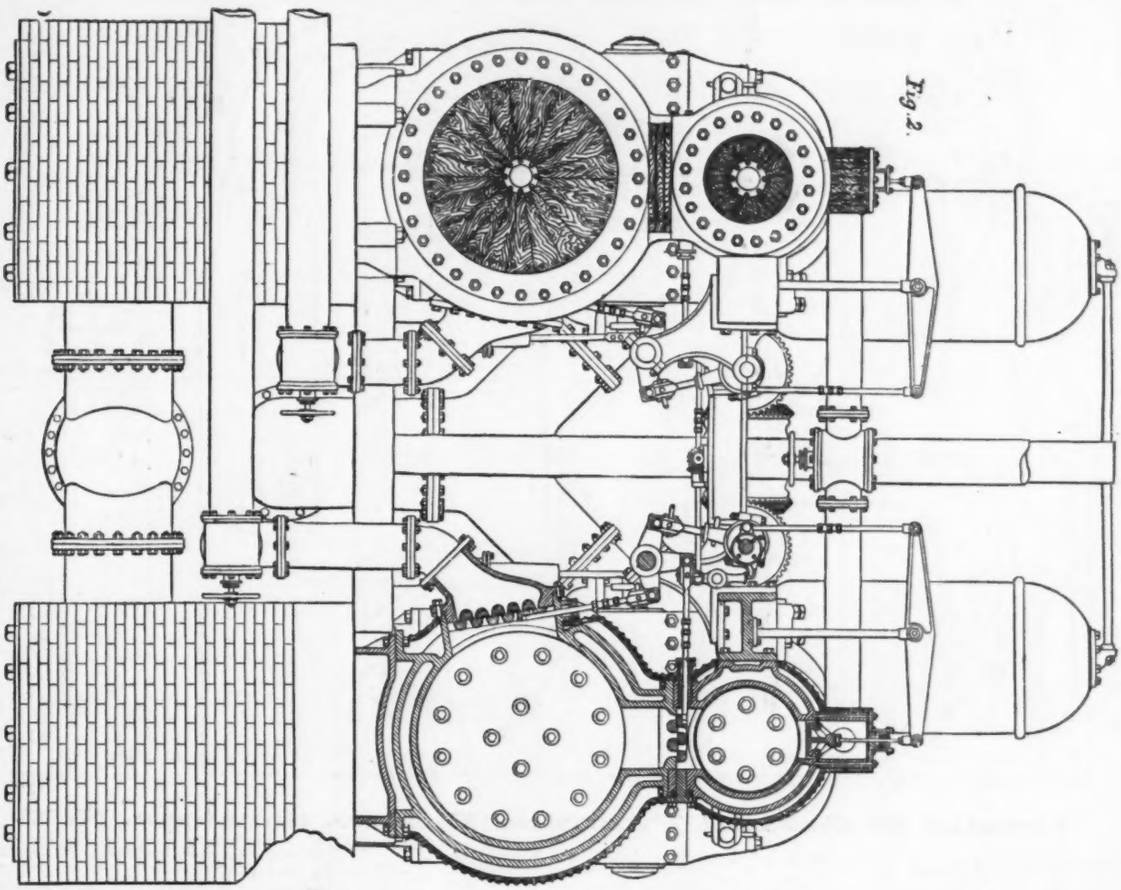

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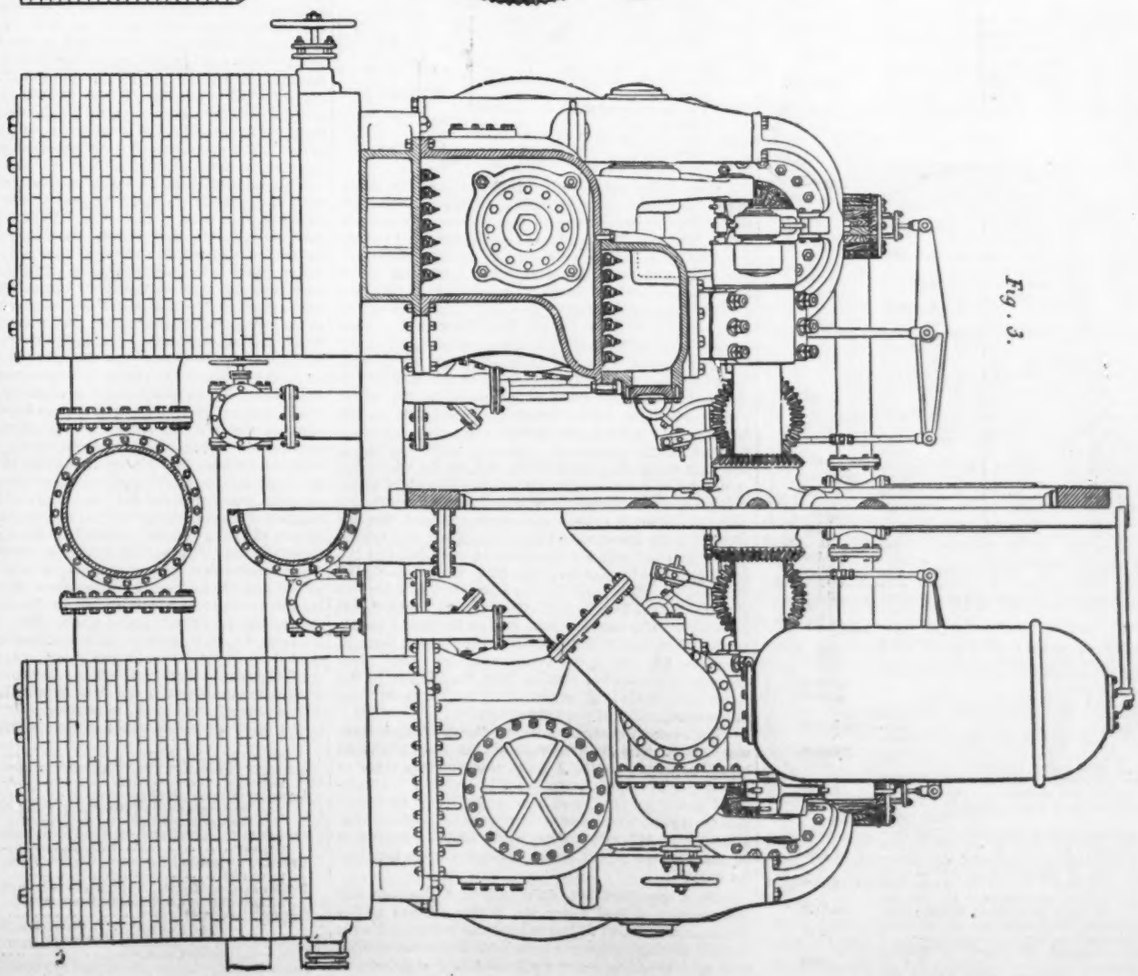

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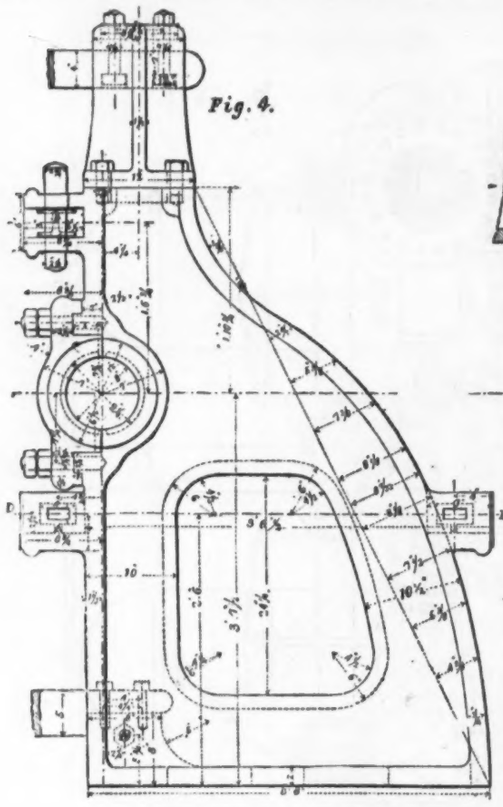

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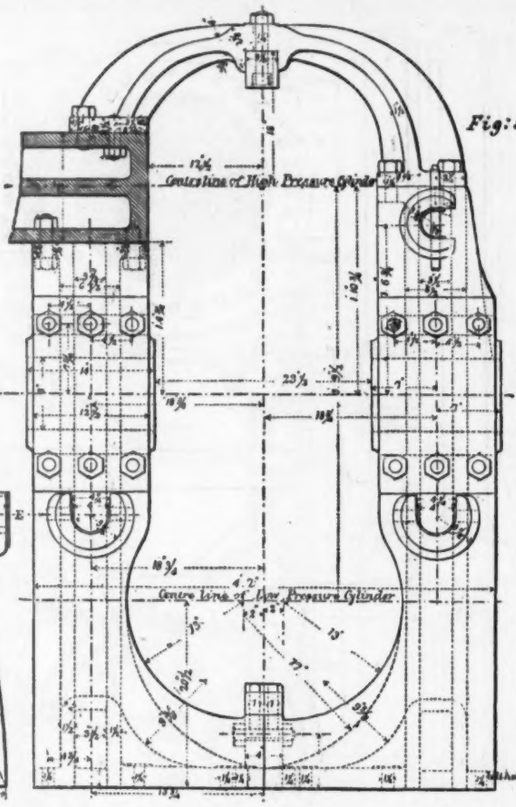

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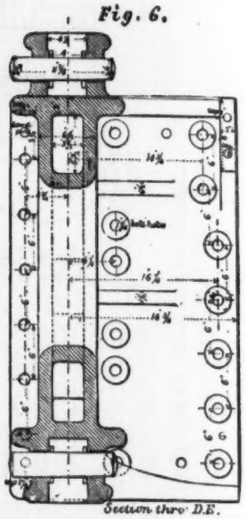


Fig. 6.

Section thro' D.E.

Details of Gaskill Pumping Engine, Saratoga, N. Y.

Water evaporated	155,961 lb.
" " by combustion of 1 lb. of coal	9.25 lb.
Average temperature of feed water	71.5 deg.
" pressure of steam, by gauge	73.66 lb.
Number of thermal units contained in 1 lb. of steam	1211.1
Equivalent evaporation from 212 deg., under one atmosphere	10.916 lb.
Evaporation per hour from each one square foot of heating surface	1.175 lb.
Engines:	
Average number of revolutions made per minute	19.370
Average piston speed, in feet	116.220
Pressure of the atmosphere, in pounds on the square inch	14.500
Average horse-power exerted in high pressure cylinders	109.200
Average horse-power exerted in low-pressure cylinders	76.559
Average horse-power exerted total	185.759
Pounds of coal burned per hour	351.000
" " " " horse-power per hour	1.900
Pounds of water evaporated per hour	3250.000
" " " " horse-power per hour	17.500
Pounds of water evaporated per hour for each horse-power exerted in the high-pressure cylinders	30.000
Total average back-pressure in high-pressure cylinders, pounds	12.500
Pounds of water per hour accounted for by indicator:	
1. At point of cut-off in high-pressure cylinders	2061.000
Proportion of the quantity evaporated	.634
2. At point of release in low-pressure cylinders	2880.000
Proportion of the quantity evaporated	.886
Temperature of the steam in all jackets, degrees	318.700
Temperature of high-pressure exhaust (average)	204.000
Temperature of low-pressure exhaust	153.000
Pumps:	
Number of double strokes of each plunger per minute	19.3700
Mean of velocity of plunger, in feet, per minute	116.2200
Number of valves acting together	84.0000
Diameter of each valve opening inches	1.3125
Total area opened by valves, square inch	113.6000
Lift of each valve, inches	.3125
Mean velocity of water through valves, in feet, per second	5.2500
Weight of each valve, pounds	.5625
" " for each one square inch of opening, pounds	.4160
Resistance to current on each one square inch of opening, pounds	.2600
Total loss of efficiency in pounds on square inch	(.416 + .26) × 2 = 1.3520
Mean excess of pressure in the delivery main pounds on square inch	84.5700
Proportion of power lost in passage through valves	.0160
Time occupied by valves in closing seconds	.0400
Motion of plunger while valves are closing, inches	.0700
Proportion of stroke lost in closing of both admission and delivery valves	.0040
Net delivery from both pumps per double stroke, U. S. gallons	190.0000
Net delivery from both pumps per double stroke, pounds	1584.0000
Delivery per day at 18 revolutions per minute, U. S. gallons	4,924,800.0000
Number of double strokes made in 48-hour test	55,779.0000
Net foot-pounds of work done on each double stroke	309,338.0000
Net foot-pounds of work done by consumption of 112 lbs. of coal	114,620,800

A U. S. gallon weighs 8.33 lbs.

A comparison between the indicated and the pump horse-power was made by taking diagrams, both from the cylinders and pumps, in the middle of every six hours' interval. The average of eight such observations gave the work in the cylinders as 311,117 foot-pounds per revolution, and the work in the pumps as 304,466 foot-pounds per revolution. According to this the average loss per revolution, due to friction of engines and pumps, was 2.14 per cent. Mr. Porter says: "I am disappointed in the result of these comparisons of the indicated power with the useful effect in the pumps. Irregularities appear, the cause of which, however, is obvious. The fluctuations of pressure in the main, rising and falling twice during each revolution, to different points and through different periods rendered it difficult to fix the mean pressure with exactness, although much care was taken, and, on the whole, the errors doubtless balanced each other. The chief cause of the discrepancies was, however, that in a few minutes generally about five—that necessarily elapsed between recording the observations and completing the taking of four pairs of cylinder diagrams, the pressure in the main was sure to change a little from variations in the demand for water, and the pressure in the cylinders would vary in a like degree. The average result shows a loss from all causes of .0214 of the indicated horse-power. The loss in the passage of the water through the valves was .016 of the pressure, which would leave only about one-half of one per cent. for friction in the machinery. This friction was small, but the power lost in it was a good deal more than that.

"The average water pressure in these selected cases was 83.19 lb. The real average during the forty-eight hours' test was 84.57 lb. I have assumed this error to afford a measure of a corresponding error in the indicated power exerted, and have accordingly increased this from 182.6 horse-powers, the measures of the diagrams, to 185.75 horse-powers, which I have assumed to be the average power really exerted during the test for duty.

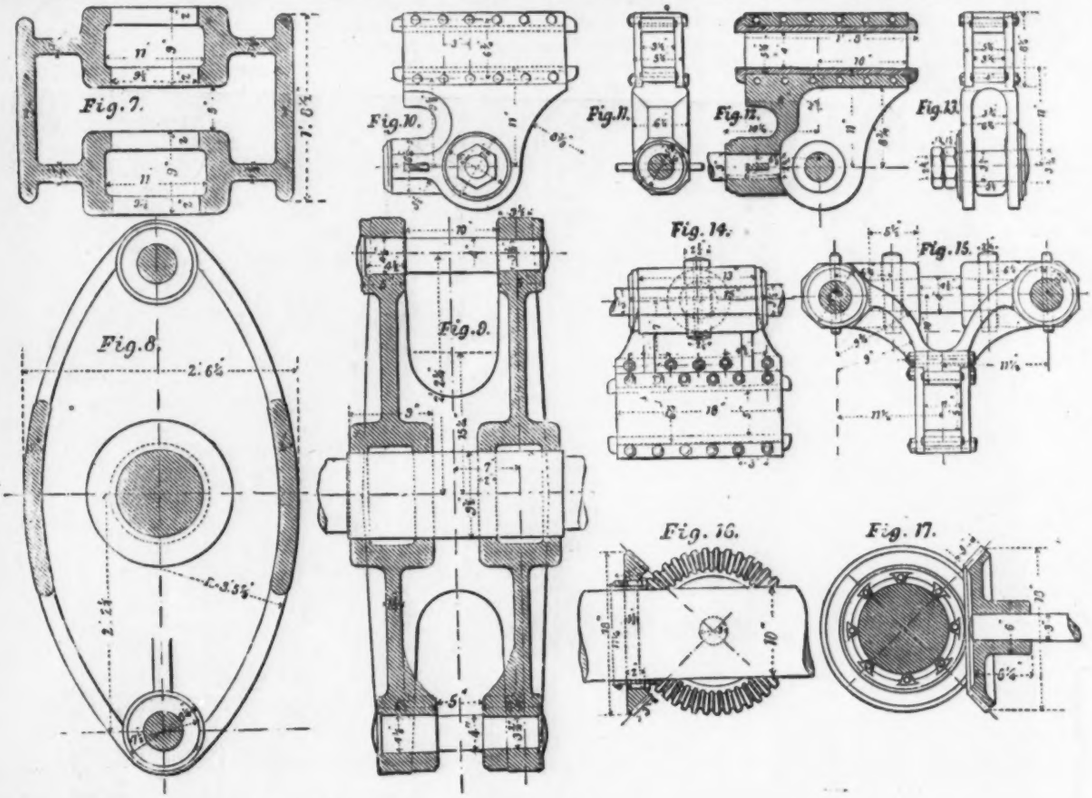
From a consideration of the indicator diagrams and the amount of feed water, Mr. Porter arrived at the conclusion that .365 of the steam was condensed as it entered the high-pressure cylinders. This computation took no note of the water condensed in the jackets, as that was returned to the boiler, and not included in the measurement of the feed water. During the expansion in the high-pressure cylinders, in addition to the re-evaporation of water formed, by the conversion of heat into mechanical work, about one-half of the above-mentioned water was re-evaporated, increasing very much the pressure at the end of the stroke. When the communications to the low-pressure cylinders were opened a fall of pressure to the amount of 10 per cent. was immediately necessary to fill the waste room in those cylinders; all fall of pressure beyond that amount at that point was caused by condensation of the steam in entering those cylinders. The loss was afterwards made good by re-evaporation in the low-pressure cylinders, and something more, so that at the end of the stroke 88.6 per cent. of the water supplied to the boiler was present in the state of steam, and only 11.4 per cent. in the state of water. The most important fact disclosed was that the earlier the cut-off in the high-pressure cylinders, and so the lower the point reached by the expansion, the less would be the proportion of the steam condensed in entering the low-pressure cylinders. It seems that the jackets can maintain these at only a moderate temperature, and therefore the higher the pressure at which the steam is exhausted into them the greater the quantity which is instantly condensed. There was a difference in this respect between the two engines which could not be accounted for, as it was ascertained that the valves were all tight.

In conclusion, Mr. Porter states that the degree of economy attained, although excellent when judged by existing standards, is still far short of that which engines of the character are capable of; that the economy in the high-pressure cylinder, taken above, is inferior to that obtained in first-class non-condensing engines; and that further economy is to be obtained by preventing in a greater degree than at present, the transfer of heat from the steam in the steam-pipe to the condenser without doing work. This can be done, he says, by employing a higher piston speed, or by moderate superheating of the steam. A combination of these would doubtless effect a further increase of from 20 to 25 per cent. in the duty obtained.

In a second duty trial, extending over twenty-four hours, Mr. Porter gathered the following data:—

Duration of trial, hours	20
Average pressure by engine gauge, pounds	74.25
Average vacuum, inches	27.295
" temperature of injection, Fahr.	56.225
" temperature of overflow, Fahr.	71.125
Average temperature of feed-water to boilers	169.175
Average pressure by gauge on force-main, pounds	95.06875
Difference of levels, centre of pressure gauge and source of supply, pounds	9.09965
Revolutions in 20 hours	21,449
" per minute	17.8742
Piston speed per minute, feet	107.2452
Total coal burned, pounds	6,750
Calculated discharge of pumps per revolution, U. S. gallons	191,923

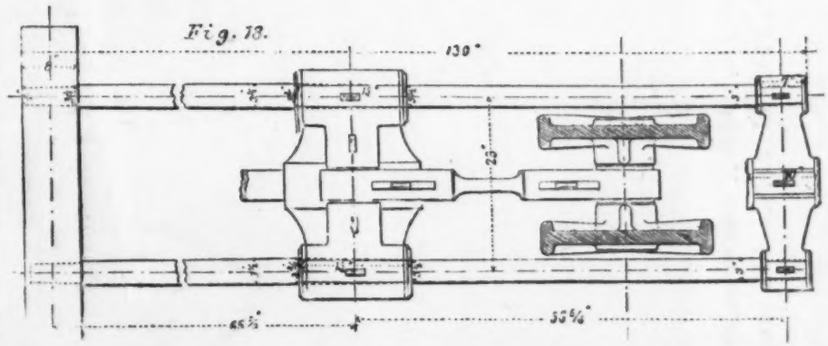
DETAILS OF GASKILL PUMPING ENGINE, SARATOGA, N. Y.



Actual estimated discharge of pumps per revolution, U. S. gallons	187,125
Weight of water per gallon at 56 deg. Fahr., pounds	8.33
Contract delivery at 18 revolutions, U. S. gallons	4,000,000
Actual estimated delivery at 18 revolutions, U. S. gallons	4,850,280
Excess over contractor's guarantee, per cent.	41.125
Contract duty per 112 lb. coal	89,600,000
Conventional duty as per trial	126,437,980
Excess over contractor's guarantee, per cent.	21.257
Net absolute duty, as per trial	121,848,759
Excess over contractor's guarantee, per cent.	36
Total horse-power developed	197.78
Coal per indicated horse-power per hour	1.705
Duty of engine base, on total work	129,957,895

This gives an even more surprising result than Mr. Hill's trial. Mr. J. G. Mair said, in a paper contributed to the Institution of Civil Engineers, that the losses with large compound pumping engines range from 18 to 20 per cent., with lifts of 130 ft. and upwards. The Gaskill engine has no air pump, and thus it is in a better position as regards loss of power than most engines. As a matter of comparison we may adduce the trials of a pair of compound beam pumping engines constructed by Messrs. Simpson and Co., and supplied to the West Middlesex Water Works. The two high-pressure cylinders were 29 in. in diameter by 5 ft. 6in. stroke, and the low-pressure cylinders 47½ in. in diameter by 8 ft. stroke. The contract was that 3,456,000 gallons should be pumped in 24 hours, and that the coal per pump horse-power should not exceed 2.3 lb. per hour, equal to a duty of 96.4 millions, after 5 per cent. had been deducted from the pump displacement. The head on the pump was 187.7 ft., and therefore the conditions were very similar to those at Saratoga. The trials showed a consumption of 1.91 lb. and 1.53 lb. respectively per pump horse-power and per indicated horse-power, with a duty of 116.1 million foot-pounds. Thus it will be seen that the Gaskill engine is not quite equal to the best English standards. It seems probable that the jackets were working badly, and that they allowed either air or water to accummulate in them, or there could not have been so much condensation. No doubt a close scrutiny would disclose some defect in this respect, and this idea is confirmed by the difference of results obtained in the two engines. If the present excessive condensation of steam in the cylinders were greatly reduced, as it should be, a notable increase would be effected in the fuel economy, and even better results than those recorded above would be shown by the indicator.

MESSRS. GETH & BARTHELS have taken the contract to build the new St. Francis German Catholic Church, St. Paul, Minn., for $10,804. A. M. Radcliffe, architect.

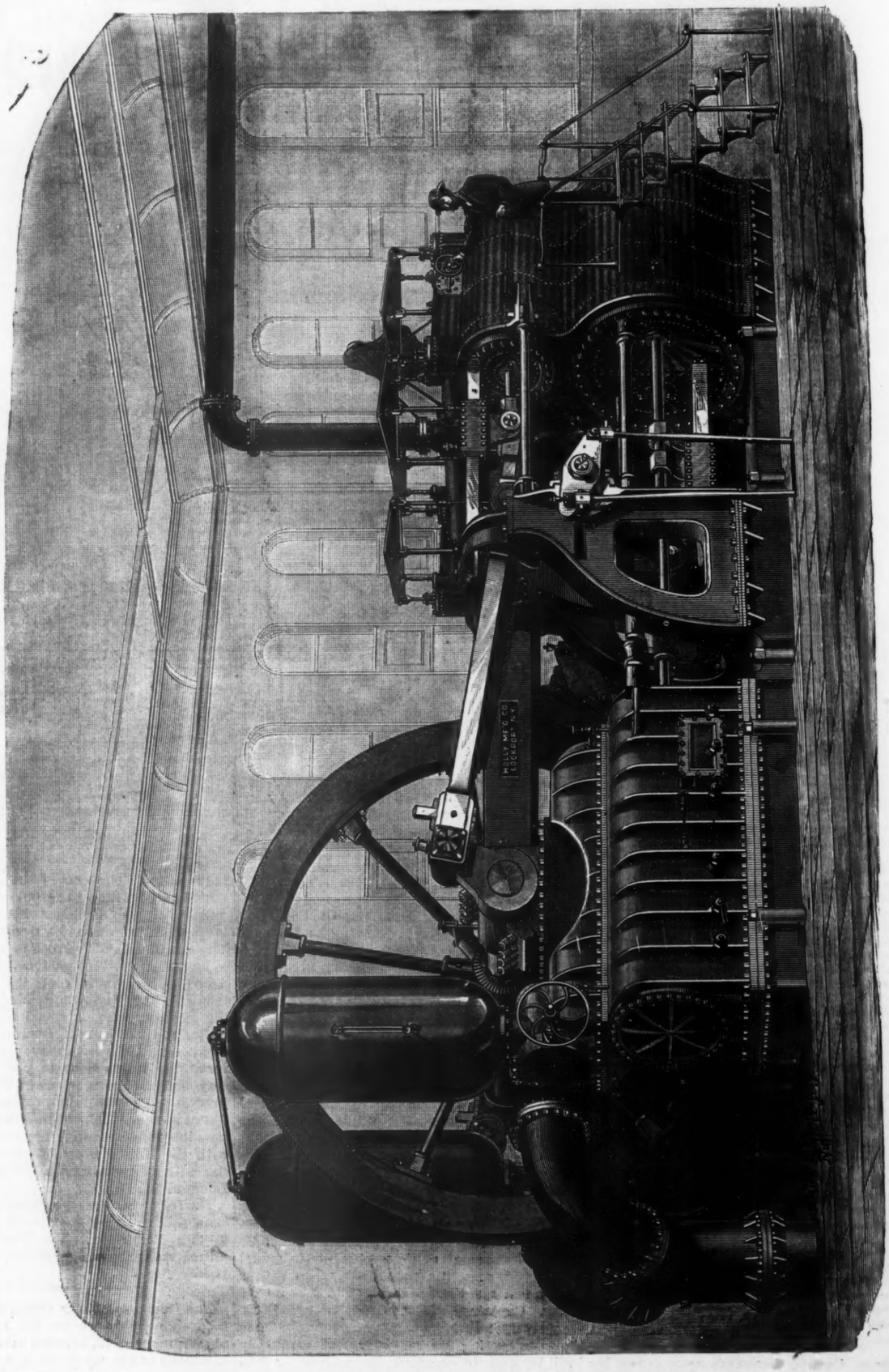


The Tehuantepec Ship Railway.

Captain James B. Eads was at the Fifth Avenue Hotel on Monday, having been absent in London during several months, being engaged there in submitting to English capitalists his project for a ship railway from the southern extremity of the Gulf of Mexico, near Minatitlan, across the isthmus of Tehuantepec or Gulf of Mexico to Tehuantepec. Before he left London he exhibited to about 70 of the most prominent scientific men of the British Empire a model of his ship railway. Among those present the builder of the steamers Alaska and Oregon. Mr. William John, the superintendent of the ship building works at Barrow-on-Furness; Chief Constructor Barnaby, of the navy; Sir Edward Reed, M. P., formerly the constructor of the navy; Mr. Lista, Chief Engineer of Liverpool docks; Sir Frederick Bramall and Mr. John Fowler. Captain Eads has brought with him the cradle in which the small ship belonging to the model rests, and, also, the ship itself. The ship is seven feet and the cradle six feet four inches long. Captain Eads says that he shall rely mainly upon English capitalists for assistance in constructing his railway. He thinks he will be able to complete the railway in five years from the present time. The distance from Minatitlan, the terminus of the Gulf of Mexico, to Tehuantepec, on the Pacific Ocean, is 130 miles. The cost of the railway is estimated at from fifty to seventy-five millions of dollars. It will be constructed to carry the largest ships which go around Cape Horn. The maximum of the gross weight of the ships to be transported is 5,000 tons. Captain James Andrews, the builder of the jetties at the mouth of the Mississippi; Mr. Van Brocklin, the engineer who surveyed the Tehuantepec route, and Mr. Albert Lucius, a mechanical engineer, all of whom have been in London assisting Captain Eads in presenting his railway scheme there, returned with him on the Oregon. The Captain proposes to visit the jetties at the mouth of the Mississippi on business in connection with his existing contract with the United States Government, and on the 24th of next month he will return to London.

The following are the distances by the various sailing routes mentioned from this city to San Francisco: Via Tehuantepec, 4,741 miles; via Panama, 6,218 miler; via Cape Horn, 16,360 miles.

THE House Commerce committee agrees to a favorable report on the bill authorizing the appointment of a Missouri river commission, to consist of five members, to superintend and carry into execution the plans for the improvement of the navigation of the river from its mouth to its head waters.



THE GASKILL PUMPING ENGINE, SARATOGA, N. Y.

Constructed by the Holly Manufacturing Company, Lockport, N. Y.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

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For information concerning back numbers of Engineering News, see advertising Page X of April 12th and 19th.

Engineering News and American Contract Journal is growing, notwithstanding the cry of hard times and slack business. The growth is, moreover, a healthy one and is sure to continue. The engineers and contractors of this country are finding out the value of a well patronized, well conducted class journal devoted to their interests, and our subscription list and advertising pages are the indexes of their appreciation.

For certain lines of business we claim unreservedly the leading position as an advertising medium. If there is one superior in those lines to be found in the country, we want to buy advertising space in its columns.

The paper on Kansas City Sewerage by Robt. Moore, C. E. of St. Louis Mo., published this week will be followed by Mr. O. Chanute's reply next week.

The next meeting of the American Society of Civil Engineers will be held at 127 E. 23rd St. on the evening of May 7th. There will be a collation served after the meeting, and if any of the hitherto indolent members who "would like to be there," but are too fond of their "slippered ease" at home to make the trip, will only submit to the martyrdom once, they will become constant attendants thereafter. Secretary Bogart is hard to beat as a host, as well as a secretary.

The Annual Convention of the Society commences June 10th next at Buffalo. A very long list of notable names appear as the local committee, and it is time that members began planning for their annual vacation. The charms of Buffalo and its near vicinity to Niagara cannot fail to tempt a large representation.

At the meeting of the Civil Engineers' Club of Cleveland on Tuesday evening last, Mr. S. J. Baker of the City Civil Engineer's office read a paper on the "Original Survey of Cleveland." We dare not hint at what the paper told, as we are in receipt of a rather savage epistle from City Civil Engineer Morse himself concerning our report of his paper on the Foundations of the Cleveland Viaduct published last week. If we are to take time to send all over the United States to verify newspaper reports, we will have to abandon the publication of a *Newspaper* altogether. If Brother Morse had taken the same time spent on his fault-finding letter, to send us a corrected copy of just what we printed it would have been more satisfactory. Mr. Croes in his Water-works Statistics has got considerable correct information only by publishing the best he could obtain, but which provoked parties into sending corrected notes. If engineers expect thoroughly satisfactory reports by us, they must "lend a hand" themselves. They needn't say do not report their papers; we will, and to the best of our ability.

The anonymous writer who asked us about switch and frog calculations, will find everything he needs in any one of the excellent "Pocket Books" for Engineers now for sale in the book stores.

The paging of Vol. X. Engineering News shows an omission from 516 to 529. There is no break in the succession of issues. The printers raised the price of composition on us that week, and signalized the occasion by sundry freaks of just that kind. It was one of the incidents that led to the establishment of our own composition room, and the increased enterprise on our part to produce a better paper than under the previous system.

If railroad construction is falling off materially, the outlook for construction of waterworks, sewers, pavements and other municipal and government improvements is certainly very encouraging. There never was such a demand for the appliances of healthy and luxurious living, and for the conveniences of trade and commerce as there is at the present time, and it is to Civil Engineers that the public looks for devising and constructing all such.

The Fourth Annual Convention of the American Water-works Association.

The fourth annual convention of the American Water-works Association was practically a great success, and will undoubtedly be instrumental in still further increasing its membership and spreading its influence and usefulness. But we would that every man connected with the supply or distribution of water was enrolled among its members.

The construction of water-works in this country of ours is still in its infancy, but it is of lusty growth and each year increases the ratio of increase. And it is to this meeting of experts, this annual comparison of methods and results, to this gathering together of men all interested in a common cause, that we must look for the perfecting of systems and the reduction of cost in supply and maintainence. By going away from home, by seeing how others do it, by chatting with brother engineers, by contrasting methods under different conditions of location and supply, all must be benefited, and the greater the numbers at each meeting and the more widely spread the experience, the more valuable will be the results obtained.

There was one feature however in this Cincinnati convention that needs a word of comment. The published programme promised twelve papers upon subjects of interest to the Association; of these, five only were read; the remaining seven were represented neither by authors nor by their papers. This should not be; twelve months is surely time enough for preparation, and if circumstances prevent the author from being present, his paper should be there. The non-appearence of this matter in any shape at the time promised puts the publishers of the programme in a false position, is a disappointment to those who come prepared to discuss them and delays their publication in the proceedings of the Association. From personal contact with the energetic and hard-working Secretary, we are assured this omission is no fault of his; it must rather be ascribed to a lack of energy and proper interest in the authors themselves.

We are glad to see this Association taking steps towards the proper formulating of annual reports. This is a matter that is sadly in need of correction. As mentioned by Mr. Gardner, detail reports are thrown away upon the stockholders, further than that portion relating to dividends. Their only value then is to the brother practitioner, and if printed at all, as they certainly should be, they should be made useful, by setting out in the clearest possible manner all that relates to the methods in use, cost and results obtained. It is by properly comparing one plant or system with another, with all the factors of locality, labor and fuel and repairs well known, that we can estimate the comparative economy, and see wherein our own system is lacking, and correct accordingly. The local board that objects to the publication of such data is blind to its most vital interests, for the money thus expended will bear interest many fold. Over private corporations who often wish to conceal the true condition of affairs, the Association will probably have no control, but with municipal works or any public supply, it is to the best interest of the tax-payers to publish the fullest details. If their works are run economically it is satisfactory to know it, and if there is waste and bad management it is still more important that they should be made aware of that fact, by having the means presented to them of comparing their outlay and returns, with those of better managed institutions.

PERSONAL.

G. H. Benzenburg, has been unanimously re-appointed City Engineer of Milwaukee, Wis., by the Board of Aldermen.

W. Baird Patten, recently with the D. & W. R. R., has been elected City Engineer of Duluth, Minn.

Chas. E. Billin, connected with the Pencoyd Iron Works, Philadelphia, was in New York on Monday last.

The wife of Gen. William Sooy Smith, M. Am. Soc. C. E., died suddenly in New York City on Saturday, the 12th. The burial took place in Chicago.

Montreal, April 23.—It is stated that J. S. Kennedy, of New York, as well as Duncan McIntyre, will shortly retire from the Directorate of the Canadian Pacific Railway. It is said that the Hon. J. J. C. Abbott will succeed Mr. McIntyre on the board.

Mr Geo. A. Ellis, City Engineer of Springfield, Mass., and otherwise well known as a hydraulic engineer, and author of the best work yet published on fire streams, was in New York on Wednesday, *enroute* from the meeting of Water-works Superintendents at Cincinnati, to his home.

Mr. J. D. Cook, of Toledo, O., one of the best known and most successful hydraulic engineers of this country, was in New York this week. Mr. Cook is Consulting Engineer of the Jackson, Tenn., Water-works, advertised elsewhere in our columns this week, and he has plans also of several new works, which will soon be offered for contract.

HENRY A. BENTLEY, City Engineer of Newport, R. I., was formerly on the staff of Gen. G. K. Warren, of the U. S. Engineer Crops. He is now actively engaged on the new sewerage system of Newport, which after many years of delay and discussion has been adopted, the plan being the one devised by Mr. E. S. Chesbrough, formerly City Engineer of Chicago.

KARL VON WAGNER, formerly Asst. Engineer with the Pennsylvania Company at Pittsburg, Pa., in charge of the construction office, Mexican National R. R., City of Mexico in 1881 and 1882, and more recently Division Engineer under the Mexican Government, of the Tehuantepec R. R., arrived in New York by the *City of Pueblo*, on the 16th.

HENRY WILLIS, of Battle Creek, Mich., expects to bring enough pressure to bear through the State Legislature to induce Congress to construct the canal between Lakes Michigan and Erie, for which he has been working years. Mr. Willis, of Battle Creek, is a sort of Michigan Lesseps. He is now 80 years old, has been at work four years to get the canal, which will be 112 feet wide and ten feet deep. Such a canal, he says, would admit vessels of 1,000 tons burden, and if built where he suggests would drain a million of acres of swamp land, making the best soil for cultivation. He is not in the least discouraged, but is still confident that he will live to see boats crossing Southern Michigan.

The American Water-works Association.

Reported by Our Own Correspondent.

[CONTINUED FROM PAGE 189.]

The second day's session of the fourth annual Meeting of the American Water-works Associations was opened in the Gibson House on April 16, President J. G. Briggs in the chair.

The first business after roll-call was the reading of a letter from J. J. R. Croes, one of the Vice Presidents of the Association. Mr. Croes stated that during the last year 170 new water-works had been built in the United States, making the present grand total of one thousand works.

W. C. Stripe, B. F. Jones and J. H. Decker, members of a committee appointed the day before, reported a resolution recording and expressing sorrow for the death, since last Convention, of Prof. Charles A. Smith, of Washington University, of St. Louis, and Mr. W. Ratekin, of Jacksonville, Ill., both members of the Association.

H. F. Dunham, of Cleveland, O., read a paper upon "Special Appliances for Fire Protection," which will be found printed in full in this number of ENGINEERING NEWS.

Carl Schön, Superintendent of the Toledo Water-works next presented a paper on "Mains Laid under Streams." Mr. Schön stated that he had attempted, by sending out a circular letter, to gather the statistics and general experience of engineers upon this subject, but had succeeded in obtaining only three or four replies. He detailed his experience in Toledo, and summed up by pronouncing in favor of a rivited wrought-iron pipe, as preferable to any type of flexible joint he had any experience with, and that this was especially the case in sandy river-beds. He did not, however, recommend it for long pipes. In discussing the paper, Mr. H. G. Holden, of Lowell, Mass., said that his experience has taught him to avoid wrought-iron under the conditions named, as it would surely and quickly rust out.

The discussion then changed somewhat to the protection of water pipes from freezing, when used in exposed positions as across bridges, &c. A number of the members present related their experience, and the final conclusion was, that there was no danger from this cause so long as the circulation was maintained, and a very small vent-pipe would prevent freezing entirely, in mains of large dimensions.

L. H. Gardner, of New Orleans, La., followed with a paper upon "Annual Reports of Water-works," Mr. Gardner thought that while annual reports, other than those relating to the financial out-come, were lost upon the stockholders, who were more interested in dividends than details, these reports should be very full. The men in charge of water-works are usually practical men, and require some checking themselves, or they should check others; this end was best accomplished by the study of full and well digested reports of their associates. The truth, and the whole truth, should be told for the benefit of their compeers, and the system, methods and accomplished results fully recorded, in fact the history of the year be written out in all its detail. The question of "How Should a Model Report be Framed?" was a difficult one to answer. The first requisite was a properly kept set of books, in which should be systematically set down, each day's work. The boiler duty should be separate from the engine duty and coal duty, the practical working of the meter-system noted; the relative merits of the many kinds of water-pipe reported, and every item of supply, distribution and maintenence recorded that could interest a brother engineer. This matter should be a fraternal duty, owed rather to the brotherhood of fellow-engineers and superintendents than to local boards or stockholders. In replying to Mr. Gardner's well expressed and well received remarks, Mr. Geo. H. Chandler of Kalamazoo, Mich., mentioned that he had, with great labor attempted to produce such a report as was recommended by the last speaker, but that his water-board had quietly shelved it, as too voluminous, and as "costing too much to print." President Briggs thought that more attention should be paid in annual reports to detailing the cost of fuel, labor, etc., because in comparing results financially of different systems and pumping stations, the element of local cost became an important factor. He thought that much good would result from sending out annually a printed form to each American water-works, and submitting these returns to a committee for tabulation, who should be authorized to criticise and otherwise handle them "without gloves." Such a tabulation would be laborious, extremely difficult if not impossible to form, but it would be very valuable for comparison.

President J. G. Briggs made some remarks upon the so-called "Indestructible, seamless, lap-welded Pipe," known otherwise as "Kalomine." He was at first favorable impressed with this pipe, and recommended its use, but he found that in his experience, it rusted rapidly and was practically worthless. He considered it one of the duties of this Association to thoroughly test this subject and to employ a competent chemist to examine into the covering matter for which so much is claimed. He recommended that a committee of three be appointed by the Association for the purpose of making this examination, and report upon its actual use under all conditions of soil and methods of laying. This motion was seconded by Mr. Geo. A. Ellis and carried.

In accordance with motions made, Frank Schefold, H. G. Holden and J. N. Carson were appointed a committee to examine into the merits and demerits of the "Indestructible Pipe"; and J. G. Briggs was made chairman of a committee to report upon the form of annual reports, with power to appoint the other members of the committee.

On Wednesday afternoon the members of the Association took carriages at the Gibson House, and under the escort of A. G. Moore and Thos. J. Bell, of the Cincinnati Water Department, and Messrs. Springmeier, Doll and Herron, of the Board of Public Works, visited first the pumping station of the Cincinnati Water Works. At this point the massive and well-kept machinery was duly examined, and the very conspicuous high water mark of the flood of 1884 commented upon. The members were also given an opportunity of witnessing the practical working of several of the Farquhar Water Filters as tested upon the muddy water of the Ohio River and as explained by the genial president of the company, Mr. Samuel L. Strang, who, as a member of the Association, was present. The members from New Orleans and other points in the Mississippi and Ohio Valleys, to whom a filter was an especial object of interest, expressed themselves as more than satisfied with the *limpid* Ohio water presented to them. This filter seems to have struck the key to the situation, in its very simple arrangement for removing the clogging deposit almost as soon as it is formed, and thus always exposing a fresh and clean surface of filtering material to the entering water. The tests made here were certainly very satisfactory to all concerned.

After leaving the pumping works, the members were driven to the "Garden of Eden" reservoir, and then through some of the very charming suburbs of the city, to the Spring Grove Cemetery, and finally halted at the city workhouse. Forbidding as the exterior appeared, a pleasant surprise awaited the visiting party within the walls; for, after Colonel Ziegler, the superintendent, had escorted his visitors through the work shop, dining rooms, etc., he led them into the Chapel of the institution, where well-spread tables and tubs filled with long-necked bottles, greeted the appreciative eyes of the somewhat tired and hungry party. After justice had been done to the substantials, speech making was next in order. Mayor Stephens, of Cincinnati, and ex-Gov. Young, of Ohio, spoke for the "Queen City," and bade a hearty welcome to its guests; President Briggs and Messrs. Gardner, Jones, Decker and others replied on the part of the Association, and bore testimony to the warmth of the greeting extended to their organization.

The first business of the evening session, held at the Gibson House, was the following report, relating to the question of annual dues, etc., brought up at the first day's meeting:

> Your committee to whom was referred for consideration the suggestion regarding dues and the methods to be adopted to increase the welfare of the Association, and assist the president and secretary in their annual address, respectfully recommend the following: First, that article No. 3 of the By-laws be amended to read as follows: "For active members, the entrance fee shall be $5, and the annual dues $3; for associate members, the entrance fee shall be $10, and the annual dues $3." Second, that the secretary be required to prepare and send to every water works in the United States and Canada, a paper which will show the object of the Association, the work already accomplished, the great benefit that will accrue by a connection with it, and soliciting each of the water works to send a representative to the next annual meeting and enroll as a member of the Association.
>
> THOMAS J. BELL.
> GEORGE A. ELLIS.
> L. A. GARDNER.
> Committee.

Edwin Darling, of Pawtucket, R. I., then read a paper upon "Water Meters," describing briefly the various kinds of meters in use and the advantages of the meter system. The paper was discussed by some of the members.

At the morning session of April 17, Messrs. L. A. Gardner, F. J. Holden and Richard Holmes, Jr., the Committee, upon nominations for the officers of the coming year, reported with the following result: Officers for 1884-85; President, L. H. Gardner, of New Orleans, La.; Vice Presidents, W. C. Stripe, Keokuk, Iowa, Edwin Darling, Pawtucket, R. I.; George A. Ellis, Springfield, Mass; A. G. Moore, Cincinnati, O.; B. F. Jones, Kansas City, Mo.; Secretary and Treasurer, J. H. Decker, Hannibal, Mo. The next annual meeting will be held at Boston, Mass., commencing on the third Tuesday in April, 1885.

At 11 a.m. the members boarded a steamer and proceeded, first to the Cincinnati and Newport Pipe Works, at Newport Ky., where they witnessed the several operations of moulding and casting iron pipe; the out-put of the day preceding the visit of the Association was

103 tons of iron pipe. Next the party were carried up river to the Markley Farm, the proposed site of the new Water-works for Cincinnati, and returning stopped at the pumping station of the Newport Water-works, which cost that ambitious town about $800,000. Upon the return trip a collation was served upon the boat, and the time sped rapidly in listening to speeches made by the Mayor of Newport, the representative of the Cin. & Newport Pipe Works, and other prominent citizens; among these was Gen. Al. Berry of Newport, a typical Kentuckian, in inches and in eloquence, who believing that the visitors had had enough of water, dilated upon the merits of Old Bourbon, the speed of Kentucky horses, and the beauty of Kentucky women generally, and of the Blue Grass region especially. Responsive speeches were made by Messrs. Briggs, Gardner, Stripe, Ellis, Darling, Moore, Hill, John C. Kelly and others; the last named gentleman, the President of the National Meter Co. of New York, fired the heart of the natives by reminding them that he himself was of Cincinnati birth, having left that City twenty-five years ago, with uncertain prospects and little fortune, to return as the head of a successful and prosperous business house of acknowledged reputation. At the Cincinnati Landing, the Association scattered, some to their homes, others to still more distant fields of investigation, and by unanimous consent this Fourth Annual Meeting of the American Water-works Association was voted a success.

AT the meeting of the Aqueduct Commissioners last week, a communication was presented from Engineer Newton, of the Department of Public Works, pointing out that Congressman Potter, in his computation of storage required in the Croton basin, made an error of 8,520,000,000 gallons. Mr. Potter included that amount in the average flow of the river, whereas it was storage drawn during the year from the reservoirs. Chief Engineer Church submitted a report as to when the plans for the aqueduct would be ready. Before the plans can be prepared complete and final plans of the ground and of the exact location of the shaft must be had. The plans of the aqueduct would be ready in time to proceed with the work when the legal formalities for the taking of the land by process of law have been complied with. In another communication Engineer Church asked the commission to decide as to whether ground water was to be admitted to, or excluded from the aqueduct. If it was to be excluded it would be necessary to line the aqueduct with brick to a greater thickness than one foot. Millions of dollars would be saved in the cost of the masonry if it is to be admitted. The water was probably of the same nature as that in the Croton district. If any flowed through lime rock strata it would tend to make the water hard, and where such water was found he thought it would be advisable to exclude it.

Engineer Church next presented a report on the Quaker Bridge Dam. In it he said that the erroneous impression had been given, that as soon as the new aqueduct is built the city will enjoy an abundance of water. It was utterly fallacious, in his opinion, to suppose that the building of the Sodam Dam, together with the utilization of storage on Croton Lake, would be sufficient to satisfy the city for a term of years and give time for further increase as occasion requires. The new aqueduct and the Quaker Bridge Reservoir were dependent upon each other, and it would be as unwise to delay the construction of the dam as to postpone the beginning of the aqueduct itself. The maps and plans for the aqueduct, as prepared by the Department of Public Works, were adopted and signed by the Commissioners.

AN English steamer has arrived at Vera Cruz with 20,000 sacks of hydraulic cement for the harbor works of that port.

Special Appliances for Fire Protection.*

BY H. F. DUNHAM, C. E.

Mr. President and Members of the Association.—The subject of the paper which was assigned to me, as it appears upon our order of exercises—*Special Appliances for Fire Protection*—would include a wide, and a yearly increasing field where the inventor's accumulated wisdom and his keen ingenuity are closely associated, and to mention in brief the past years' addition to the devices and improvements, and new methods for extinguishing fires would fill a longer paper than you can expect from me.

But I was not left to select and describe such improvements as I deemed of greatest importance. The topic given to me was modified in the Yearly Report and there read, *Special Appliances for Fire Protection. The Rate at which the Necessity for Reservoirs or extra Pumps Diminishes as the Population and Consumption Increases.* It seemed almost necessary to write a paper in order to establish the proper relations between the different lines of thought naturally awakened by this expansion of the subject, and I trust you will bear with me if I reverse the order, and give more attention to that gradual change in the storage of water for fire purposes, which every city undergoes, than I do to any slight modifications, or improvements, or appliances that have occurred to me as being possible under certain conditions.

It is not my purpose to dwell upon the early growth or development of a city's Water Supply. It is familiar to you all, and you know how in one respect it resembles the growth of vegetation. Its earlier forms are the simpler and more readily understood. With every addition new principles are introduced and the simpler forms become complex in a geometrical ratio.

The wells and lifting pumps; the street reservoirs; and the hand engine; the days when people discover that insurance rates are high, and well water unhealthy; the contract, the laying of pipes, the hydrants and fire streams; these things are of frequent occurrence, and closely enough does this last stage resemble that period in plant life when the buds give place to blossoms and promise an excellent harvest.

Up to this time it is not difficult to obtain a record of what has been done, and the reasons for doing it, but of the further work, the cultivation and perfectness of the kernel, the most valuable and interesting of all the processes, it frequently happens that nothing, or little is recorded. The annual expense account cannot be overlooked, I know, but it requires the explanations of a superintendent, or such knowledge of the conditions as he only possesses, to make it valuable, and I am in a rather embarrassing position, having to encounter difficulties in the presence of those who are especially skilled in surmounting them, but who have not been especially careful to record their own methods.

An early cause of trouble and annoyance comes to notice after the water has been conveyed some distance from the main, as to outlying districts which required no large quantity of water, and where there has been a close grading down of pipe diameters, 10, 8, 6, 4, and so on, the last being large enough for house connections, but none too ample for fire protection when the works were new.

Suppose at the trial test, four good streams had been thrown from the hydrants near the small end of such a pipe line. Every subsequent year, with its list of new buildings has increased the demand for better fire protection.

And with each yearly list of small connections outside, and each annual growth of tubercles inside the street main, its capacity for fire purposes has diminished. The four effective streams are reduced to three, then to two, and the question which lies close to the heart of the superintendent is what shall be done?

Setting more hydrants will not insure a greater number of more powerful streams, although it might increase the revenue. To lay a new main or to reinforce the present one may be thought too expensive by the directors, and being a provision for an emergency that might not occur at once, it would naturally be postponed.

The chief of the fire department upon hearing an alarm from that quarter, is hardly certain that his streams, No. 1 or No. 2, can be used to advantage. He knows just what is required—that the largest possible number of streams should be turned upon the fire immediately. He knows, too, that if he attaches a stream to a hydrant he will practically destroy the value of the streams from the adjacent hydrants. A natural suggestion would be to provide an old-fashioned brick cistern to be kept full and in order at all times. This would insure an extra fire stream, but it would entail extra cost, care and attention, and waste of water also. A device simpler in some respects, and practicable, wherever a superintendent thought an extra stream for fifteen or twenty might be worth an outlay of $200, more or less, would be to provide a wrought-iron tank, with a capacity of three to four thousand gallons, from which a stream could take its supply without interfering with the flow of water in the main. There should be proper gate construction, and the tank could be refilled before the fire was extinguished if there chanced to be a surplus of water due to shifting hose or shutting off a hydrant, and as such changes are frequent during a fire, an extra stream might be depended upon for a longer period than that required to first empty the tank.

But to obtain the full value of a special appliance of this kind, it would be necessary to insert a clause in contracts made with some water companies, to the effect that wherever pipes of too small diameters to give reasonable fire protection were put down, the company should construct and maintain such storage tanks at its own expense. It is true, that people are often negligent about securing a water supply, and even fail to be grateful for benefits conferred upon them; but when fire protection has been promised by a company, such protection ought, on general principles to be provided. When a fire occurs in a village, or a small city there is an instant demand upon the reservoirs or the pumps, and all depends upon the supply from them. In a large city an ordinary respectable fire could without difficulty be extinguished, if the pumps were to be stopped, or the reservoir gates closed at the time the fire broke out. These assertions are not startling, and require no proof, but they are important and should be kept in mind by every superintendent. In the small city there are no large pipes; not many connections, and there is only a small quantity of water available. In a large city there are longer mains, and the city itself is one great reservoir filled to the third, or fourth or fifth floor, as the case may be.

It is a reservoir that the Water-works engineer did not create, and use with a capacity that he did not figure out. The superintendent began upon its foundations, when he placed the first "service," and turned the water into a three-quarter pipe, and he improved the opportunity to make some valuable changes in the original plan before he fitted up the modern business block with its tank capacity of fifteen thousand gallons, and made provision for daily supply in excess of that quantity.

Not only in a broad and general view, but in detail, step by step, from first to last the subject is full of interest. The results which are brought about unwittingly and by necessity in thickly settled districts are the very results to be desired in places where the population is but scanty. And whatever causes operate to produce these results should be carefully traced, adopted and augmented, if possible, in the smaller places. Upon one side toward the dense population there is a limit beyond which extreme care seems unimportant. Upon the other side there is no such limit.

In certain portions of a city numbering half a million, the superintendent might, without much risk, store ten thousand gallons of water where it would not be available for fire purposes. But he should not take the liberty to do that in a city of a few thousand inhabitants. In some parts of Philadelphia, even, he might hesitate.

This work of enlarging and connecting is not so obvious, but it is quite as important as would be the work of raising in the center of a fire district, and by yearly additions, some lofty water tower that should at last offer ample protection and mark the skill and industry of the superintendent.

As a matter of fact, superintendents are pulling down similar structures, and offering as effective supplies from works of their own, unnoticed, but near at hand. The methods to be settled and the possibilities within reach, vary with the hundred different phases of situation and circumstance. Work that might be useful in one place would be lost in another. Few matters of detail could be generally adopted. When it is necessary to take water rapidly, but for only a short time, from a street main as to fill vats, boilers, etc., an auxiliary tank is of service. As the connection with the main is smaller than the outlet pipe, the tank serves to sustain the pressure in the main and to prevent it from being subjected to severe concussions and strains. Were such tanks or reservoirs to be made large enough to serve as small air chambers also, still better results might be expected. They would not be very expensive nor require great care.

To put them into hotels, business blocks, etc., would be to greatly assist the fire department at its first effort.

We know about the friction head in long smooth pipes. We do not know much about it when the pipes are not smooth and where there are a hundred openings through which the water escapes. Still less do we know about what that co-efficient of friction would be if on opening a hydrant one half of those hundred connections should deliver a quantity of water under reservoir pressure *back into the main.* For that we have no formula. That condition would extend the field for study and experiment by which some errors might be avoided; but then as now the object at which to aim and which requires increasing care would be the gradual development and perfection of a system in all its parts until like a man with a strong pulse, like a body of men well trained, it was quick to respond when the time for action came and the demand was made upon it.

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* Read before Am. W. W. Ass'n, Cincinnati April 16, 1884.

On The Cleaning of Aqueducts.

Written for Engineering News.

BY DESMOND FITZGERALD, C. E., SUPT. WESTERN DIV., BOSTON WATER WORKS.

The city of Boston derives its water from three sources. Excluding the Mystic River works, which supply a limited area, added within a few years by annexation, the city proper is supplied from Lake Cochituate and from the Sudbury River. An independent aqueduct connects each of these sources with the distributing reservoirs. The Cochituate Aqueduct, which is of egg form, with the large end down, is 6 feet 4 inches high by 5 feet wide.

It was first used in 1848. The Sudbury River Aqueduct, completed in 1878, is 7 feet 8 inches high by 9 feet wide.

Previous to the building of the latter structure, the city was wholly dependent upon the Cochituate aqueduct, and to keep up the supply the water was sometimes allowed to stand more than two feet above the top of the arch at the upper end, thus running the brick work under a head as if it had been a pipe. The water procured in this way was equal to the daily consumption, so that it will be seen not very much time could be allowed for cleaning or repairs.

The consequence was, that for a number of years the interior was not kept in a desirable condition as regards cleanliness. It was the custom to depend largely upon flushing to complete such sweepings as might be hastily made. It is impossible wholly to get rid of the dirt from an aqueduct in this manner. There is always a considerable amount of slimy growth which even after being dislodged with the broom will cling to the bottom with great pertinacity, and which requires the application of manual force for its removal.

The writer has frequently noticed that after water was let on for the supply of the city, it was dirtier for a number of days than it was before the interruption in its flow. Sometimes the lighter particles would be present a week after the partial cleaning. This led to the belief, which was entertained for a long time, that the less the uniform flow in an aqueduct was disturbed the better the water would be. With the completion of another aqueduct, allowing of more opportunity for the study of the interior, a better knowledge of affairs has been arrived at. It is undoubtedly true that if the interior of an aqueduct is neglected, its surface will accumulate an amount of filth which will affect the quality of the water.

The following is a section of the Cochituate Aqueduct:—

Its length is 14.3 miles and its fall 3¼ inches per mile. The upper end for about two miles from the lake is always found to be the dirtiest. The *Spongilla lacustris* here flourishes in the greatest profusion. If a few years are allowed to elapse without a thorough cleaning almost every square foot of brickwork in that distance will be covered with the long finger-like shapes of this nauseating animal. An ordinary sweeping will then only remove the exterior or longer portions, leaving a particularly tenacious growth of a cell like substance.

When a thorough cleaning of this portion was first attempted in the Cochituate Aqueduct it was found necessary to scrape this apparent foundation of the sponge growth with tools especially prepared for the purpose. The *spongilla* has never been found to any great extent below this section of two miles, but a sticky, slimy, vegetable growth is always present after the water has been drawn off.

There are on the Cochituate Aqueduct, four waste-weir buildings where water can be emptied. There are also a syphon blow-off and a plug at two other points, making 6 places where water can be turned into the brooks, or roughly at every 2½ miles of conduit. Intermediate man-holes give access to the interior when the cleaning is to be done in a shorter time than three days, necessitating the cutting up of the length into shorter sections. A cleaning accomplished in a single day is only done at more expense and vastly more trouble than if a reasonable time is allowed, into the details of which it will be unnecessary to enter here. It is found that owing to the slight inclination and the imperfect floor line of the Cochituate Aqueduct, it is impossible to empty it entirely. There will always be about eight inches of water in the bottom even when the head gates are shut entirely down. This is ample water for cleaning purposes.

A small gang of men are kept constantly at work on the Sudbury and Cochituate Aqueducts. They become after a few years' training expert in all kinds of work of maintenance such as grading, repairs of masonry, etc. These men form a necessary nucleus for the cleaning. At least one of them leads each gang of seven, and sees that the allotted amount of work per man per day is accomplished. This amounts in the Cochituate Aqueduct to 10,600 square feet of brick surface swept three times over, or 620 lineal feet of conduit.

It requires, on a three days' basis, 123 days labor for each cleaning. Good, stiff corn brooms are used for all but the invert, and on this portion rattan stable brooms are necessary. For lighting the interior candles are used. Experiment has been made with a number of other kinds of light, but candles have given the best satisfaction. Formerly an extra man managed the lights for each gang, but this has been superseded by a method which allows each man to attend to his own light.

A tin reflector holding two candles is attached to the thigh so as not to interfere with the motion of sweeping and at such an angle as to throw the light on the work. It requires 6 candles per man per day. It is needless to say that hip rubber boots have to be provided, and these boots are good for some half a dozen cleanings. As an honest days' work under these peculiar conditions is fatiguing, it is well to furnish teams to take the men back and forth in the morning and at night. We are thus enabled to estimate pretty clearly what a cleaning, such as has been described, costs for an aqueduct like the Cochituate:—

123 day's labor, at $2*	$246.00
Candles	19.68
Brooms	25.00
Rubber boots	20.00
Foreman, 3 days, at $3.50	10.20
Miscellaneous, 10 per cent.	32.11
Total	$353.29

* Price fixed by City Council.

The Sudbury Aqueduct, a section of which is here given, has a wetted perimeter at the

present ordinary flow line somewhat less than the Cochituate when it is running, as it usually is, nearly full. It is found necessary to sweep only about a foot above the water line. An average day's work per man is in this structure 8,350 square feet of brick surface swept three times or 580 lineal feet. These estimates do not include the expelling of the dirt after it has been dislodged. Usually reliance has been made upon flushing for this purpose, but the writer is convinced that it is impossible to do this part of the work thoroughly in this manner. The following method has been found effective but one requiring considerable time. The work of cleaning is carried on upstream. A greater head of water is then let on, amounting, in the Sudbury Aqueduct, to a flow of 6,000,000 gallons per day or about a foot in depth. The men then work down with the current stirring up the deposits and sweeping the floor clean. Experiments are now in progress for doing this portion of the work by a machine.

The Sudbury Aqueduct, which roughly has a capacity of 100,000,000 gallons per day or about five times that of the Cochituate, is 15.6 miles long. Like the latter, there are half a dozen places where the water can be emptied. The inclination is one foot to the mile and owing to its perfect construction practically all the water can be taken out. It requires a depth of about 4½" or a flow of 800,000 gallons per day for cleaning and this leaves about one foot of the invert on each side bare. The modus operandi of cleaning is as follows:

The water having been drained out during the night, the men enter in gangs of seven the next morning. Three men work on each side so that each man has to do as much as the leader, an old hand, or fall behind. The seventh man works on the bottom with a rattan broom. The first broom removes the worst portion of the growth, and the two following brooms complete the operation. This leaves the brickwork of the sides clean and the growth on the bottom dislodged. The following is the cost of cleaning the Sudbury Aqueduct:

46 men, 3 days, 138 days at $2	$276.00
Candles	22.08
Brooms	29.34
Rubber Boots	25.00
Foreman, 3 days at $3.50	10.50
Miscellaneous	37.08
	$400.00

If the cleanings are carried on, and the dirt expelled by manual force, in the manner indicated, the water will run perfectly clear in half an hour after it has arrived at any waste weir. It is the intention to clean the aqueducts mentioned once in every six months, and the work is very much easier performed if this plan is carried out. In the spring of the year there are always large amounts of water running to waste, and this time will naturally be one of the periods selected. A word more in relation to the invert of an aqueduct. For the best form of maintenance, the invert should be uniform and continuous throughout the whole length of the structure whether in tunnel or elsewhere. If any breaks in the grade or catch basins are built, they should be near the waste weirs where the material deposited may be easily taken out. On the Cochituate Aqueduct the Newton tunnel, half a mile in length, has a very rough bottom imperfectly concreted. The writer has seen a deposit of mud and sand in this tunnel extending throughout its whole length, and so deep that it was almost impossible to walk through it. A gang of twelve men worked with shovels and wheelbarrows for seven days getting out this material at a cost of $200. The quantity was 350 cubic yards.

It appears from a recent statement made by one of the most extensive iron founders in England that, owing to the improvements lately made in the manufacture of coke, the yield of the latter, per ton of coal, has been increased from about sixty per cent. to seventy-five and seventy-seven per cent. At the same time that the yield of coke has been thus increased, the by-products have been utilized to the extent of seven gallons of tar and thirty gallons of ammoniacal liquor per ton of coal. This advance in the utilization of by-products means, in a word, a reduction in the cost of the production of iron.

American Society of Civil Engineers.

APRIL 16, 1884.

The society met at 8 P. M., President D. J. Whittemore in the chair, John Bogart, Secretary.

A paper by Hamilton Smith, Jr., M. Am. Soc. C. E., "On the Temperature of Water at Various Depths in Lakes and Oceans" was read by the author.

Mr. Smith expressed the opinion that the temperature of water drawn from a reservoir at a depth of 170 feet would be much more constant during the year than if drawn from a point, say 60 feet below the surface. He stated that at one of the North Bloomfield reservoirs in California, formed by a masonry dam about 100 feet in height, the water was drawn from a point about 90 feet below the top of the dam. In July when the temperature of the air is often above 90 degrees, the water near the surface is too warm for drinking and not to cold for bathing, while the water from the deep point is almost icy cold. In the winter months, with a depth of 50 to 60 feet of water, that drawn from the bottom is from 5 to 7 degrees warmer than the stream water in the neighborhood; this fact being of great practical advantage, as the comparatively warm water enters the open canal of the company and retains more or less of its high temperature for a distance of 15 miles, even during snow storms, while in other canals of that neighborhood whose water comes from running streams, the flumes soon become choked by snow unless they are covered,

A number of observations upon the temperature of water were given. Those made by F. A. Forel at the Lake of Geneva, Switzerland, showed a surface temperature ranging from 41 degrees to 71 6/10 degrees and a constant temperture of 41 1/10 degrees at a depth of 984 feet. The range at the depth of 164 feet was only from 43 7/10 to 44 8/10. This lake rarely freezes. Observations upon other Alpine lakes were given with the same general results. Prof. Wm. Ripley Nichols found the temperature of Fresh Pond at Cambridge, Mass., with a range of from 82½ degrees to 33½ degrees at a depth of 2 feet below the surface, while at a depth of 35 feet the variation was only from 51 degrees to 34½ degrees.

Prof. J. LeConte found the temperatures of Lake Tahoe, California, at 1506 feet below the surface to be 39 1/10 degrees, when at the surface it was 67 degrees. This lake has never been frozen across. In ocean soundings the "Challenger" found in latitude 37°31' South, longtitude 36°07' West, a temperature of 30 8/10 degrees at a depth of 16,050 feet, and in several other soundings temperatures of 31 3/10 and 31 4/10. The "Blake" found north of St. Thomas in the West Indies 36½ degrees at a depth of 37,366 feet, which is notable as being the deepest sounding thus far made. At this point the surface temperature practically remains constant at 80 degrees. The Blake soundings also show that in this heated current rapidly moving northward from the tropics there is a very rapid diminution of temperature even at very small depths. The explanation of these low summer temperatures at considerable depths in bodies of fresh water is that water being most dense at about the temperature of 39 2/10 degrees, the surface water which becomes cold in the winter gradually sinks, and water being a poor conductor the strata at depths of 200 feet or more, will retain during summer this lower temperature with but slight variations, although the surface may become heated up to 32 degrees, as at Fresh Pond and perhaps even higher at other points. This theory does not seem to account for the very low temperature of 30 3/10 degrees recorded by the "Challenger," or that of 36 7/10 degrees by the "Blake." Possibly pressure may be a factor in this problem. There are great practical difficulties in determining accurately temperatures at such enormous depths.

In the soundings near St. Thomas the pressure of water amounts to near 12,000 pounds per square inch. Comparative tests however of the latest models of thermometer used by the United States Coast Survey show satisfactory results. It is evident, therefore, that in a reservoir near this locality the surface temperature may reach 85 degrees in July and August, and go to 33 or 34 degrees in winter, while at a depth of 170 ft. it will not vary greatly during the year from 45 degrees; this being on the assumption that the reservoir remains full. Where water can be obtained from depths of 60 to 170 feet, this consideration should have weight in determining the point from which it can be most advantageously drawn. On account of this lower temperature the water will probably be more free from organic matter or organisms. Of course bottom temperatures will become elevated as heated strata from near the surface find their way towards the bottom.

In the discussion of the paper, Mr. N. S. Keith described the construction and operation of the Electrical apparatus used for ascertaining temperature at great depths. The paper was further discussed generally.

Arrangements were announced for the Convention of the Society to be held at Buffalo, N. Y., June 10, 1884.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(Continued from page 191)

DCXXIII. NEW BETHLEHEM, PA.

New Bethlehem, Penn., in lat. 41° N., long. 79° 20' W., is on Red Bank Creek in a rough, hilly country.

It was incorporated a borough in 1852. Water-works were built in 1883 by a private company, the supply being taken from Red Bank Creek. The water is filtered through a bottomless box of 2 in. white oak plank, 8 ft. square and 4 ft. high, filled with stone, and is pumped by a Worthington steam pump of 10 in. water cylinders, lifting 197 ft. to a reservoir box of 2 in. white pine plank, 30x64 ft., sunk 8 ft. in the ground at 165 ft. above the town.

Distribution is by 1½ miles of cast-iron pipe of 6 and 4 in. diameter, with 11 fire hydrants and 5 gates. The number of taps is not given. Service pipes are of lead and galvanized iron. $25 yearly is paid by the borough for each hydrant. The population, in 1880, was 773, it is now said to be 1,100. The works have cost $10,500. The capital stock of the company is $10,000. There is no bonded debt. E. V. Marsh is president, and Geo. S. Thomas, superintendent.

DCXXIV. WOODSTOCK, ONT.

Woodstock, Ontario, Can., in lat. 43° 10' N., long. 80° 50' W., is on the River Thames. Settled in 1830, it was incorporated a town in 1851.

Water-works were built by a private company in 1880, for fire protection, after plans of Geo. Ware, taking the supply from Cedar Creek. The water is pumped by a duplex Worthington steam pump of 10½ in. cylinders and 9 in. stroke directly into the mains, giving a pressure of 80 pounds. There are three miles of 8 and 6 in. pipe laid with twenty fire hydrants and 6 gates. There are no service connections. The town pays $2,500 yearly for the whole fire service. The population in 1883 is given as 7,000.

The cost of the works has been $25,000.

No further information is given.

DCXXV. YARMOUTH, N. S.

Yarmouth, Nova Scotia, in lat. 43° 55' N., long. 66° W., is the county seat of Yarmouth County.

Water-works were built in 1881 by a private company, the supply being taken from Lake George which is 9 miles in length and has an average width of 1½ miles, and is 150 feet above the town.

Distribution is by 16 miles of cast-iron pipe of 12 to 4 in. diameter, with 50 fire hydrants. The number of taps is not stated. Service pipes are of lead. The town, as yet, pays nothing for fire service.

The population is given as 7,000.

The capital stock of the company is $200,000.

No further information is given.

Hugh D. Cann is president of the company, and George Bingay secretary and treasurer.

DCXXVI. OLEAN, N. Y.

Olean, Cattaraugus Co., New York, in lat. 42° 5' N., long. 78° 35' W., is in mountainous country on the Allegheny River.

It was incorporated a village in 1854.

Water-works were first built by the village in 1878, 2½ miles of pipe having then been laid. In 1883, the works were rebuilt and extended under the superintendence of S. D. Miller. The supply is taken from a well 25 ft. in diameter, and 16 ft. deep and having twenty 3 in. pipes driven 15 ft. into the bottom. A 12 in. cast-iron pipe also connects the well with the river, the water from which is only used in emergencies. The water is pumped from the well through a 12 in. cast-iron force main 2,000 ft. long, by a Worthington duplex pump of 14 in. steam and 10 in. water cylinders of 20 in. stroke to a reservoir constructed in earth excavation and embankment, 65 ft. square at the bottom with side slopes of 1½ to 1, 20 ft. in depth, and divided into two compartments by an earth embankment 10 ft. in height, all the inner slopes being puddled with 18 inches of clay and lined with brick. The reservoir holds 2,250,000 gallons and is 250 ft. above the pump and from 230 to 250 ft. above the village.

Distribution is by 10 miles of cast-iron pipe of 12 to 4 in. diameter, with 75 fire hydrants, 70 gates, 6 meters and 350 taps. Service pipes are of iron and lead.

The population in 1880 was 3,036; it is now said to be 8,000. The original works cost $6,000, and the reconstruction and extension have cost $77,000. The bonded debt is $80,000, at 4½ per cent. The receipts in 1882 were $1,800, and in 1883, $3,500. The works are managed by a board of commissioners. Wm. M. Irish is president, and L. E. Chapin, superintendent.

WATER.

THE Duluth, Minn., water and gas system will be largely increased this season, and everything will be put in first-class running order.

SAUK CENTRE, MINN., will vote on the proposition to bond the city for the construction of $14,000 water-works.

DENVER *Tribune*: There is water enough in Colorado when skilfully utilized, to irrigate 2,000,000 acres of land, which can be made to produce more wheat than is now raised in any state in the Union.

THE Hyde Park, Mass., Water Company, will lay a system of piping covering the entire township, and furnish, and put in 100 hydrants for $50 each per year, for a term of ten years. The pumping and stand-pipe system is recommended, and the average distance between the hydrants named was 700 feet. Contract has been closed on this basis.

DEAN BROS. Steam Pump Works, Indianapolis, Ind. have orders for supplying seven distilleries with the vacuum apparatus required for manufacturing spirits by the Woolner, *et al* patent process. These orders require seven large Independent Vacuum Pumps, also twelve beer and mash pumps with composition cylinders. The new process appears to be a great advance in distilling. The yield of spirits is largely increased and the old "mash tubs" abandoned.

LINCOLN, NEB., Feb. 18.—An artesian well, 4 ft. diameter, 48 feet deep, and costing $7500 has just been completed, and in a test of its capacity made, 80,000 gallons were pumped out for each of seventy-two consecutive hours. The engine was then put to work at its highest capacity, and 100,000 gallons per hour was declared to be the actual flow of water. This will supply all of Lincoln's water demand for many years to come. The city council is perfecting plans for putting in a complete system of water-works, and the work will be undertaken the coming summer.

Now that the town of Watertown, Mass., has failed because of the Governor's veto to get the water bill which was passed by the Legislature for it, the Committee on Water Supply will in the near future give hearings on the proposition to incorporate a company to supply the people of that town with water.

The sale of $600,000 St. Paul water-works bonds at a premium of 2.8 per cent. with accrued interest, on Friday is a subject of much congratulation. There were three bidders for the entire amount, all of them above par and nine premium bids for portions thereof. The award for the entire amount was made to Henry W. Cannon, Stillwater Lumberman's National Bank, who made the purchase for Eastern capitalists. The bonds will be delivered the coming week, having in the meantime to be signed by Comptroller Roche, who will have to write his name 31,600 times on the bonds and coupons attached. This sale of local bonds to outside parties is an excellent indication of the excellent financial standing of St. Paul abroad.—Minnesota *Tribune.*

The Queens Co. (L. I.) Water Company, composed of Mr. J. Lockwood and associates, has recently been incorporated. Capital stock $40,000. Its purpose is to build Water-works for Far Rockaway, Lawrence, Isle of Wight, and Woodsburgh, for which they have the franchise on condition that the works be constructed within one year. The company has made a contract with James Gamble & Mullins, 68 Wall St., New York, operations to commence immediately. There will be a stand-pipe erected so as to give an elevation of one hundred feet, equal to forty-three pounds to the square inch, and to contain about half a million gallons. Water will be obtained by sinking wells.

The company also propose to light the streets with electric lights instead of gas, as originally proposed, and are negotiating with the Edison Electric Light Co. for a plant of one thousand incandescent lights. The General Superintendent of the Electric Light Company is making an estimate of the cost, which will be ready in a few days, when work on both projects will be commenced.

According to the annual report for 1883, of the Water Commissioners of Binghamton, N. Y. (State not mentioned in the report, as usual) they have been increasing their water supply within the year by sinking a well 175 feet long, 10 feet wide, and 20 feet deep; it cost $7,000. During the year $10,377.55 was expended in replacing cement-pipe street mains with iron pipe, and $1,204.64 in the extension of street mains.

The receipts from all sources for 1883, was $50,965,00, of this $33,931.71 was from water rents and meters, and $9,380 from city appropriation. The disbursement of all kinds, including interest on bonds, was $46,135.34.

The daily average pumpage was 5,058,233 gallons; daily cost of fuel $2.95 of which 67 pounds was bituminous coal and 4,154 pounds, screenings. There are now 24 miles, 130 feet of mains in use, of which 12½ miles are iron. It has cost to date $54,084,91 to relay with iron pipes the old cement-pipe; 67 breaks occured in this cement pipe last year, all on account of the sheet-iron lining rusting. There are in use 112 meters, 181 hydrants, and 2,600 taps.

The annual report of Minneapolis, Minn., for the year ending March 1, 1884, is received. The Superintendent furnishes an interesting sketch of the history of the works from their establishment in 1867 to the present time, giving the style and capacity of the pumping machinery, length of mains, revenue, etc. The pumping is done entirely by water-power, and the average cost for 1884 was $2.15 per million gallons, lifted 140 feet high, not including interest on plant. This is as opposed to $4.50 for the same quantity in 1883. The average daily consumption is now 7,360,964 gallons. The total receipts from water rents, penalties, etc., in 1884, was $69,061.62, as against $37,769.80 in 1883. The total disbursements during the year were $232,676.08, expended in putting in a fifth pump, of 10 million capacity, in building, and extension of mains. The present total pumping capacity is 22,625,000 gallons daily, with contracts made to increase this within the present season by an additional 20,000,000 gallons daily; 31¼ miles of iron main are in use, with 365 hydrants and 2539 taps. The water debt of the city is $507,000, and $33,000 is chargeable to uncompleted contracts. The city has now for the first time for some years a reserve of pumping power.

Since the illustration of the new Root sectional boiler, in Engineering News of February 23, 1884, orders have been received for these boilers as follows: Standard Oil Company, Long Island City, 1 of 100-horse power; E. Aaron & Co., Stapleton, Staten Island, 2 of 75-horse power; Miller Brewing Company, Rochester, N. Y., 1 of 100-horse power; W. F. & John Barnes, Rockford, Ill., 1 of 60-horse power; Philadelphia Sugar Refinery, Philadelphia, 2 of 125-horse power. The Abendroth & Root Manufacturing Company, 28 Cliff st. N. Y. manufacturers of these boilers, have also just taken an order for sixteen miles of Root's spiral pipe, for the Water-works of Stapleton, Staten Island. All this pipe is to be tested under 150 lbs. pressure. Some twenty towns in California, and a considerable number in other States, are now using this style of pipe for water-works purposes. [It pays to advertise provided you have a first-rate article to sell. Ed. Eng. News.]

City Works Commissioner Fleeman estimates that the cost of maintaining the Brooklyn Water-works during the coming fiscal year will be $358,765.50.

The editor of the Nashville *World* wrote that "all the windows in a certain dusty village looked as if they needed washing." The printers set it up "all the widows," and the *World* had some difficulty in making satisfactory explanations.

NEWS OF THE WEEK.

Mining.

The Pasadena Smelting & Mining Company, of St. Louis, has definitely decided to locate their works at Rico, and the news has caused the greatest satisfaction in that town. The reason why the news is greeted with so much delight is, because of the low price, which the company propose charging, for reduction of ores.

The company propose to do their own refining at Rico, and their charges for treatment will be $20 per ton for dry ores and $15 per ton for lead ores. The works will be started with a capacity of 50 to 60 tons of ore daily, and when success is assured this will be increased so as to meet all requirements.

A mining party of Denver, composed of Messrs. Henry C. Brooks and Aaron D. Dunbar, of Brooks, Davidson & Co., and Thomas L. Drake, have just purchased the Silver Monument Mine from Coldwell & Co., Chloride, Black Range County, New Mexico. The price paid is $15,000 cash down. The mine is not fully developed, but has shown itself a remarkable prospect, and is no doubt worth the purchase price. The Denver men intend to work the property on a monied basis, and make a financial success of their investment. Machinery is to be put in for carrying out the work.

The passing of its May dividend by the Calumet and Hecla Mining Copper Company has stirred Boston society to its foundations. For seventeen years no such untoward thing has happened to the owners of this famous copper bonanza, who have seen the shares for which they paid $12 become worth $250 apiece, and have received over $20,000,000 in dividends in that time. This money has been the source of much of Boston's outlay for art, science and "culture" generally. When young Agassiz discovered and Quincy Shaw developed the mine, the property was distributed among a very select circle of Boston and Cambridge families, and there it has naturally remained, and but a few shares come out for sale even now, though the stock dropped instantly from about 230 to about 180. Some $3,000,000 worth of unmarketable copper on hands is the cause of the passing of the dividends.

Streets, Drainage, Sewerage, Etc.

The Committee on Drainage will ask of the City Council an appropriation of $100,000 for the proposed new sewerage system under the act authorizing Lynn, Mass., to raise and appropriate $250,000 for the purpose.

Asphalte and Wood in London, Eng.—At several recent meetings of the Commissioners of Sewers, the Street Committee have strongly reported in favor of asphalte paving as against wood paving. Indeed the opinion in favor of asphalte appears to be gaining ground.

Proposals were opened in Baltimore, Md., to grade, curb and pave Chase street, from Hunter alley to North street, as follows: Messrs, Finn & Co., grading, 15 cents per cubic yard; curbing, 40 cents per foot, and paving, 5 cents per square foot, J. B. Bates, grading, 12 cents; curbing, 42 cents; paving 5 cents. A. Schneider, grading, 14 cents; curbing, 40 cents; paving, 5 cents. John Lyons, grading, 25 cents; curbing, 45 cents, and paving, 5 cents. Bids were also received for paving Hunter alley, between Read and Eager streets. The contracts were not awarded.

Cincinnati, Ohio, April 19.—For the second time it has been proved in Cincinnati that a flood instead of being followed by sickness prepares the way for a period of unusual healthfulness. It was so after the flood of last year, and is so now. A prominent physician said to-day that the flood cleaned and purified that part of the city which has always been the starting place for all the diseases which have prevailed. The flooding of the lower stories of filthy buildings, the moving of household goods to other parts of the city and the moving of them back again, and the general cleansing which the flood made necessary seems to have destroyed the lurking germs of disease. In the bottoms, where there is usually more or less of diptheria, scarlet fever, malaria, &c., at this time of year, there is now hardly a case of sickness reported. The doctors are complaining that they have nothing to do.

Railroads and Canals.

Forty-five miles of track remain to be laid on the Duluth and Iron Range Road. Track laying will soon be resumed.

Superintendent of Construction Walter Cromer, of the Bee Line, who was connected with the C., C., C. and I., died at Cleveland on last Saturday. The remains were taken to Franklin, O.

The following named railroad companies are now asking a right of way through the Indian Territory: The Kansas City, Fort Scott and Gulf, the Texas, Oklahoma and Gulf, the Atchison, Topeka and Santa Fe, the Fort Worth and Denison and the Gulf, Colorado and Santa Fe.

Engineers representing the Valley Branch of the Baltimore and Ohio Railroad have been in Roanoke and the vicinity lately, engaged in an examination of the approaches and departures to and from that city, with a view of extending the Valley Road into North Carolina.

Fourteen years ago the Atchison system, then in embryo, was composed of 28 miles of completed road within the State of Kansas. To-day it operates directly 1,820 miles and manages 800 miles more, making 2,620 miles, in addition to which it has a half interest in the Atlantic and Pacific, which would raise the total to over 3,000 miles.

This is probably the other side of the story: A gentleman who has just returned from Washington Territory was asked how he liked the country. "Well, sir, every bunch of willows is a mighty forest, every frog-pond a sylvan lake, every water-fall a second Minneapolis, every ridge of rocks a gold mine, every town a country-seat and every man a liar.

The Waynesboro' and Washington Railroad Company are considering an extension of their line into West Virginia to the great coal deposits, iron ore and lumber of that section. An extension of the road to Blacksville, West Virginia, twelve and a half miles south of Waynesboro,' would make an almost direct line from Pittsburg to the Greenbrier White Sulphur Springs. The Waynesboro' and Washington road would thus become a most important connection in promoting trade and travel North and South.

A Short Road.—One of the shortest lines of railway in America is the Nantucket Railroad, running from Nantucket to Surfside. About a year ago some waggish official of the Chicago & Northwestern sent his car tracer down to look up a Northwestern car said to have been lost on the Nantucket road. The tracer saw through the joke when he discovered that the road was on an island and that to have reached it his lost car would have had to swim. The line is just four miles long. The rolling stock is not extensive. It consists of one locomotive and five cars. The earnings last year were $5,682; net earnings, $2,515, of which $1,330 was used to pay interest.

English as She is Spoke.—The Mt. Vesuvius Wire Railway has employed some man who speaks good English to write the following circular to patrons: "Carriages are only allowed to stop for momentaneous repose of the horses. No drinking money is due to coachmen. The train is composed of ten passengers. Those who willingly lose their turn cannot profit of the next train always when there is an empty seat, but cannot pretend a special train. Guides have to behave themselves most politeful towards foreigners in showing them all the particularitys of the crater, to accompany them during the ascent and descent and bring them round the crater, etc. They are not obliged to gather stones or do impressions unless they have not bargained with them before."

The Tehuantepec R. R.—At present, native Mexican Engineers are almost exclusively employed on the Tehuantepec route. Surveys of the line have been made only by piece-meal; the principal points have been located, but so far as known, only occasional pieces of the lightest work have been touched. No heavy work has been attempted. For financial reasons, the progress is very slow and the future completion of the road is very problematical. Mexican Engineers on the Tehuantepec route are divided into 1st, 2nd and 3rd classes. The pay is from $150 to $340 per month, which includes subsistence. The cost of living in camp is about $30 per month; it is not safe to drink much of the water of the region passed through, and wine becomes a necessity; this involves an extra expense. In the matter of clothing, not much is needed, and the expense is slight.

ENGINEERS are completing their surveys up the Perkiomen Creek and along the Saucon Creek for the projected branch of the Pennsylvania Railroad, which will connect at or near Freemansburg with the Lehigh Valley Railroad.

LUVERNE, MINN., April 16.—Surveyors on the Burlington, Cedar Rapids and Northern are here locating their line through town and selecting depot grounds. Work will be commenced immediately, and pushed through the county to Pipestone City as rapidly as possible.

INDIANAPOLIS, IND., April 17.—The body of George Leah was found in White River near the city to-night. Leah was the oldest locomotive engineer in the United States, having been the first man to drive the locomotive Rocket, which was exhibited at the recent Chicago railway exhibition. He was 81 years old. It is a supposed case of suicide.

THE project to build a railroad along the north side of Long Island from Long Island City to Huntington is being revived. Ex-Assemblyman William J. Youngs, the President of the company, and Mr. Lane, the engineer, recently accompanied over the route an Amersdam banker, who, it is said, will furnish a large amount of the capital required to build the road.

GALVESTON, April 16.—The proposition by Paul Bremond, President of the Houston, East and West Texas Railroad to the citizens of Shreveport, looking to the extension of that road to Shreveport, has been accepted. Work will be commenced immediately at the Shreveport end, which, when finished will place Houston within twelve hours' run. At Magnolia the new road will intersect the Texas and St. Louis Narrow Gauge. Mr. Bremond gives a bonus of $50,000 for the right of way, depot grounds, &c.

SAN FRANCISCO, April 21.—A. J. Reynolds, fomerly a director of the so-called People's Railway, organized in Indianapolis, was horsewhipped today by Emil Kennedy, President of the same company. A fight ensued, and Kennedy drew a revolver, but was prevented from using it. Reynolds charges Kennedy with having obtained $90,000 cash through subscriptions, of which there was no accounting made; that Kennedy proposed issuing $20,000,000 of bonds at 50 cents on the dollar, taking what cash they could get and the balance in promissory notes.—*N. Y. Times.*

TROY, N. Y. April 21.—The biggest washout that has ever been known on the Lake Champlain Division of the Delaware and Hudson Railroad occurred last night. For miles between Whitehall and Ticonderoga the tracks have been washed out and lie along the shore of the lake. A strong north wind caused the high water in Lake Champlain and caused the washout. The distance between the first and last break is 12 miles.

HARRISONBURG, VA., April 18.—A meeting of the stockholders of the Washington, Cincinnati and St. Louis Railroad was held to-night, and the company was organized by the election of the following officers: President, Archer N. Martin, New York; Directors—C. E. Kimball, New York; H. D. Cooke, Washington; and U. L. Boyce, J. W. F. Allemong, and J. S. Loose, Virginia. Energetic work will be commenced on the road early in May. This road will traverse one of the richest mineral and timber sections of Virginia.

ARTICLES of incorporation of the Duluth, North Shore, and Southwestern Railroad Company at Duluth, have been filed. Capital $15,000,000. To construct, maintain, and operate a line of railroad and telegraph from Duluth northeasterly to the northeast boundary of Minnesota, and from Duluth southwesterly to the southwest boundary of Minnesota, touching at Mille Lacs, St. Cloud, Wilmar, Marshall and Pipestone City. The following compose its first Board of Directors: Herman E. Long, Vesperian Smith, William J. Tranah, Louis H. Grieser, Thomas H. Mayhew, Philip M. Groff, and Richmond D. Mallet, all of Duluth; Herman E. Long being President, and Louis H. Griesler, Secretary.

ACTIVE work has been begun on the new railroad between Nanticoke and Morgantown, where the new works of the Susquehanna Coal Company are being opened. Morgantown is located Northwest of Wanamie, and is a trifle less than five miles by the line of new railroad from Nanticoke. E. A. Tenning & Bro., of Thompsonton, Pa., are the contractors, and the work will be pushed to completion within three months. The new railroad starts in just beyond the Lehigh and Susquehanna depot. It is built by the Pennsylvania Railroad, and will be used to convey coal from the new opening to Nanticoke, from thence it will be shipped over the Nanticoke and Wanamie Branch Road, and by way of canal to market.

THE Penn. Company is now having a system of patent interlocking switches between Harrisburg and Rockville. The system is very complicated to the casual observer, but it is a wonderful improvement over the old switches, and can be operated much more satisfactorily. The switches are worked with levers at the Rockville telegraph tower, and entire safety is thus assured. Workmen are now hard at work completing the improvement.

ST. PAUL, April 12.—Careful estimates indicate that about 1,889 miles of new railroads may be expected to be added to the systems that are tributary to St. Paul. The Northern Pacific will probably complete its Cascade branch, and also contemplates two smaller extensions. The Manitoba announces that it will build 300 miles of extension, and is also talking of a new road to Yankton, which will be backed by this company. The Rock Island will also make additions. The New Sault Ste. Marie expects to complete 100 miles of its road this season, and the Fargo Southern will doubtless be in operation to Flandreau before fall. Other extensions of old roads are proposed, as are several new lines.

THE Pennsylvaia lines owned East of Pittsburg and Erie number 16, while 84 are owned and controlled by it, making 100 in all. Two of these are canals, three are ferries and three bridges—leaving 92 distinct lines of railway. West of Pittsburg and Erie it controls, mostly under lease, 46 lines and branches, besides two bridges and two depots—making a grand total of 150 separate transportation lines and terminals, of which 138 are railways. A large proportion of these were originally built by distinct organizations. The magnificent system extends through thirteen States. Of first track it has 6837.61 miles; of second, 1028.70; of third, 160.93, and of fourth, 80.89. It has 2103.97 miles of sidings of its own, besides 363.66 miles used by private parties. The grand total of track of all kinds is 10,575.76 miles.

A FREE PASS CARRIES DAMAGES.—The Court of Appeals has decided in the case of Mary A. Seybolt against the New York, Lake Erie and Western Railroad that a railroad company is responsible for damages in case of the death by an accident on the road of a person traveling on a free pass. Daniel H. Seyboldt, husband of the plaintiff in this case, was killed in an accident on the defendant's railroad at Tioga in 1881. He was a postal clerk running on that road. His widow claimed $5,000 damages for his death, and in a suit brought by her against the company the trial court awarded her $1,500. The company's defence was that the deceased clerk was at the time of his death traveling on the road by virtue of a free pass, and, according to the conditions of that pass he was not entitled to recover damages. On an appeal to the General Term by the company the award was sustained, and the Court of Appeals has just affirmed the judgment.

THE fiftieth anniversary of the opening of the railroad from Philadelphia to Columbia was observed with some ceremony in Columbia last week. This event marked the birth of the Pennsylvania Railroad system. The original purpose was to connect Philadelphia with the canal system of the State, and the first charter for the horse railroad to Columbia was granted to John Stevens in 1823. The enterprise failed, and in 1828 the Legislature authorized the construction of the road by the State, Major Wilson being the engineer. The road was finished and opened April 16, 1834, the Philadelphia terminus being at Broad and Vine Streets. The road was at first operated as a public highway, individuals owning the cars and horses. There were no time-tables, and the right of way was curiously governed. At every mile and a half was a turnout. Half way between there was a large post, and whichever driver on a single track passed this post first could go on, while those he met were compelled to pull their cars back to the turnout. The State was soon obliged to operate the road it owned. In 1833, a steam locomotive was given a trial, and in June, 1834, Mr. Baldwin built the Lancaster, the first locomotive put in use on the road. The first train ran from one end of the road to the other April 16, 1835, making the eighty-two miles in four hours.

This road was the beginning of the Pennsylvania system, whose main tracks could now be made to reach from Philadelphia to China; whose cars and engines would reach from Lake Erie to Atlantic City; whose employees would form a line from Philadelphia to Trenton; the steel and iron of whose rails and rolling stock would make a shaft eight inches in circumference and 25,000 miles long; whose treasury receives $1000 an hour and whose net earnings would pay 2½ per cent. interest on the national debt.

A CROOKED PIECE OF RAILROAD.—The extension of the Nevada Central Railway from the valley of the Reese river up Pony canon, through the city of Austin, Nevada, is about 2½ miles in length, in which distance there are employed over forty different curves, varying from 2° to 40°. The grades vary from level to 8 feet per 100, and in a distance of 10,300 feet an elevation of 636.25 feet is obtained. To overcome this elevation within the above distance, it was necessary to resort to one switchback, and 200 feet between centers of track a difference in elevation of 75.5 feet was acquired. The use of such excessive curvature was made necessary by following an old wagon road, cut into the rock on the precipitous side of the canon. Considering the resistance of the curvature on this, it is thought that it encounters the steepest grade of any road now in operation in this country, upon which steam is used, applied to friction.

THE Wisconsin, Minnesota and Pacific Company has located the new extension of the Pacific division of the Minneapolis and St. Louis road from Morton, the present terminus to the Dakota line, a distance of eighty-five miles. A contract for the grading has been let to Winston Bros., who are to commence work at once, beginning at Morton, where the line crosses the Minnesota River, and building northwest, striking the Dakota line about fifteen miles south of Ortonville. The road is to be in operation in September, in time to move the new crop. This extension, after crossing the Minnesota River at Morton strikes on to the prairie about fifteen miles south of the river, running then parallel with it and crosses the Lacqui Parle River in Riverside Township. There are no towns started of any importance anywhere along the line. The country is said to be one of the finest sections in Minnesota. President R. R. Cable, of the Rock Island, and several others of its leading officials, were in Minneapolis last week in consultation with the construction company of the road.

PHILADELPHIA, April 21.—Two hundred employees of the Baldwin Locomotive-works have been discharged owing to lack of orders, and the remaining men are to work on two-thirds time during the next 30 days. The number of employees will be reduced one-half "The cause of the present trouble," said the Superintendent of the works to-day, "is a remarkable depression in the locomotive building trades. We have not received a large order here for several months. The works have been running 3,000 men, but that force has been reduced to 2,800, and by the time we have finished 38 engines for Brazil and the Argentine Republic, which will be within a month, the force will be cut down to 2,000 men. The capacity of the works is 12 locomotives a week. With the reduced force we will be able to turn out six weekly. The orders we had for the Mexican National and Mexican Central Roads have been completed. How long the depression will last is, of course, beyond conjecture, but from the present condition of the market it is evident that the works will be compelled to run short for at least six months. About six hundred men will be discharged before the end of May.

WITH the formal organization of the New York Cable Railway Company, and the accompanying transfer to it of the recently created franchises for cable railways in this city, the Rapid Transit Commission finished its work. The company was organized Monday afternoon by the election of officers and Directors and the signing of the articles of incorporation. The Directors elected were Homer A. Nelson, William S. Williams, Wallace C. Andrews, Roland N. Hazard, Thomas F. Ryan, Augustus C. Moss, Thomas W. Evans, Joseph J. O'Donohue, and W. P. Shinn. The officers were: President, Wallace C. Andrews; Secretary and Treasurer, Thomas F. Ryan. Thirty-one stockholders, representing 18,500 shares, were present. James Gamble, representing 250 shares; F. F. Thompson, 500 shares; H. O. Moss, 250 shares; L. F. White, 100 shares; M. B. Brown, 100 shares; E. L. Oppenheimer, 100 shares; George Henry, Jr., 100 shares, and Edwin Lord, 100 shares, were absent. The Directors appointed the President and Secretary and William P. Shinn a committee to prepare by-laws for the company.

During the afternoon the formal transfer of the franchises was made. The company now stands upon what some of its members proudly speak of as "vested rights." It will occupy the rooms of the Rapid Transit Commission until May 1, when an office will be selected. It is expected that work on new cable routes will be begun within a few weeks. Either the Lexington avenue line or the Tenth avenue line will be built first.

The Rapid Transit Commissioners have 30 days in which to settle their accounts and retire from office. It is probable, however, that they will retire in a few days.

A BRANCH road from Petersburg to Exeter mills in Chesterfield county, Va., a distance of twelve miles, will shortly be built at a cost of $15,000 per mile.

COLONEL H. T. DOUGLASS, chief engineer of the Philadelphia branch of the B. & O., returned recently from inspecting the work along the line. Two caissons are being sunk for the bridge over the Susquehanna, and now that the spring has opened, work over all the divisions will go on faster. It was reported from Belair that surveyors of the Pennsylvania road on the 10th, ran a line on the south side of Deer Creek, from Cooksville to Wilson's Dam, and on the 15th, made a survey on the north side of the creek, from the mouth of Columbian run to Stafford. It is thought the object is to extend the Philadelphia and Baltimore Central Railroad towards Baltimore. In case the Baltimore and Ohio transfer their freight traffic to Southeast Washington, a connection will have to be made with the Virginia Midland Railway, and in the event of their using the Long Bridge, the protective committee will urge that a suspension bridge be built in place of the one now in use. Electric lights will shortly be used by the Baltimore and Potomac Company along Virginia avenue.

ARTICLES of incorporation of the Minneapolis, Mille Lacs and Northern Railroad Company have been filed. The general nature of its business is to acquire and maintain a railroad and telegraph line from Minneapolis to Princeton, in the county of Mille Lacs, thence via Mille Lacs Lake, Leach Lake, Winnebagoshish Lake and Red Lake, to the Lake of the Woods, at or near the boundary of Minnesota. A branch will run from this line to a point on Rainy Lake River, also a branch from Princeton to Brainerd, or to Wadena via Little Falls. Capital stock $5,000,000. The names of the gentlemen who have signed the articles as incorporators are: Thomas Lowry, E. M. Wilson, Henry Hills, R. P. Russell, John Baxter, Horace Henry, John R. Walcott, Samuel B. Tibbets of Minneapolis; C. H. Chadbourne, H. B. Cowles, Charles H. Rines of Princeton, Minnesota; George F. Brott, Washington, D. C.; M. C. Tuttle, St. Paul; Charles T. Gregory, Winnepeg; Charles Jay, Newburgh, Vermont. The first Board of Directors are: Thomas Lowry, E. M. Wilson, Horace Henry, R. P. Russell, Henry Hill, George Brott, Hiram B. Cowles, Charles H. Rines, and M. C. Tuttle.

Gas and Electricity.

JOHN WATSON & Co., have the contract for the construction of the new telegraph line from Minneapolis to Madison, Wisconsin, to connect there with a new line from Chicago to Madison. Work on the eastern section—Madison to Chicago—has been in progress several days, and will be completed in about six weeks. M. L. Town, of the firm of John Watson & Co., began work on the western section at Madison a few days ago, working this way. Mr. Watson with another crew of builders has begun work from Minneapolis.

A COMPANY of Bucyrus, O., capitalists were organized some weeks ago to experiment by boring for natural gas. McFarland & Co,, of Pittsburg, took the contract to bore 500 feet under the supervision of Colonel U. C. Semert, of Bucyrus. The shaft is being sunk near the O. C. Railroad roundhouse at the east edge of the corporation. One hundred and fifty-sever feet were reached lately but with no results. Bed rock was struck, which will retard the progress of the drill, The hole starts with a diameter of six inches. The projectors anticipate discovering a sufficient supply of the natural fluid to utilize it in heating the various power engines in the city. This is based upon the fact that gas has been discovered in small quantities in this locality at shallow depths.

CHICAGO, April 20.—The Chicago Sectional Electric Underground Company, represented by its legal adviser, J. R. Doolittle, Jr., Robert Stewart, general superintendent, and M. A. McLeese, its electrician, has asked the Commissioner of Public Works for a permit to utilize the privileges by the Council to build a conduit, in which to lay telegraph wires, in the following route: On LaSalle Street, from Thirty-ninth to Twenty-second; on Twenty-second Street, east to Dearborn; north on Dearborn to Fourteenth Street; West on Fourteenth to Clark; north on Clark to South Water Street, and east on the latter street to Michigan Avenue. It is the intention of the company to build conduits in Van Buren, Madison, Clark, LaSalle, and other streets in the business part of the city. The conduits will be operated by the Bankers and Merchants' Telegraph Company. The work will be commenced immediately and it is expected will be completed in three weeks. There will be about sixty wires, coiled in several cables, laid in the conduit, and they will connect with lines running to Eastern and Western cities.

A MOVEMENT is on foot to organize the American Institute of Electrical Engineers. A meeting is to be held on Tuesday, May 12th, at a place to be announced hereafter. Those interested may obtain particulars by addressing Mr. N. S. Keith, No. 237 Broadway, New York City.

AN instance of the practical application of science to every day life is well shown in the building of the capitol building of Dakota, at Bismarck, by the aid of electric light. This building, costing a quarter of a million of dollars, consists of three stories, basement, and sub-basement, measuring a hundred and fifty-five feet by ninety-two feet, and contains over four million bricks, with trimmings of Joliet stone, and has been erected in the midst of winter. The corner-stone was laid September 5, 1883; and on January 10, 1884, a few days more than four months later, a photograph shows the building to lack only the projection of one side and the upper part of the tower. This result was accomplished by the employment of electric light, which half the time replaced the sun, enabling doubling gangs of men to work day and night. The frozen sand was thawed by a red-hot cylinder; and the mortar, made with boiling water and hot lime, had its moisture absorbed by the dry bricks before it had time to freeze. Although caller, the building is an almost exact duplitate of the new capitol of Minnesota.

Contracting Miscellany.

COOPERSTOWN, Dak., is to have a new court house and jail.

THE contract for a new county building at Olivet has been let.

JAMES FINNIGAN has received the award for the excavation for the public building at Syracuse, N. Y., at 30 cents per cubic yard.

Three thousand kegs of nails have recently been received for the fluming of the Dallas, Col., placer ditch, and 3,000 kegs more will be required to finish it.

THE plans of Bruce & Morgan, architects of Atlanta, Ga., have been selected for the new court house to be built at Covington, Ga. They are also preparing plans for the Lawson-McGhee memorial library at Knoxville, Tenn.

ROANOKE CITY, Va., is to have a cotton factory. It will cost $300,000. Of this sum, Philadelphia capitalists have subscribed $200,000, and the business men of Roanoke $50,000. The additional $50,000 required will probably be raised in a few days.

WASHINGTON, April 18.—The Committee on Rivers and Harbors voted to-day the sum of $100,000 to commence the building of a breakwater at Sandy Bay, Rockport, Mass. The matter, which at the start seemed to have little prospect of success, has been admirably managed by Colonel Sanborn, the agent for the petitioners. General Parke, of the Engineer Corps, who has charge of rivers and harbors, deems this sum amply sufficient for the first year's work.

CHICAGO, April 19.—The ambitious project of constructing an island in Lake Michigan, opposite this city, is seriously to be undertaken this summer. The magnitude of the venture can be understood when it is known the plans contemplate an area of forty acres. This island is to be guarded by a breakwater seventeen feet in height. It is to be placed one mile from the shore, where the depth of the water averages eighteen feet. On the shore side is to be a land-locked harbor of seven acres to admit lake craft of any size. The land is to be formed of sand and clay dredged from the lake. The face of the island is to be irregular, and the summit of the gradual swell is to be the site for a large hotel. This being the highest spot on the island, and fully fifty feet above the water-line, will afford a magnificent view. The projectors number several experienced engineers and have made their estimates on the basis of a total expenditure of $2,000,000. It is thought that the resort would prove popular as a place for summer cottages and would attract summer people generally, and particularly Chicagoans desiring to have an easy escape from the city in her hottest moods.

BIDS FOR PUMPING MACHINERY AT MARE ISLAND, CALIFORNIA.

The following are the bids, opened January 22, 1884:

James Edwards & Co., New York City, $74,250.
Union Iron Works, San Francisco, Cal., $50,600.
Southwark Foundry Company, Philadelphia, $47,900.
Daniel C. Buhre & Co., Brooklyn, $69,700.
Thomas C. Basshor & Co., Baltimore, $75,000.
Parke & Lacy, San Francisco, $42,200.
Awarded to Parke & Lacy.

BIDS FOR FLOATING GATE OR CAISSON AT MARE ISLAND, CALIFORNIA.

The following bids were opened January 22, 1884:

Union Iron Works of San Francisco, Cal., H. T. Scott, Vice President, $64,000.
Pacific Iron Works, Rankin, Brayton & Co., San Francisco, Cal., $72,500.
Risdon Iron Works, San Francisco, Cal., W. H. Taylor, President, $73,500.
Awarded to Union Iron Works.

STONE AND BRICKWORK AT FRANKFORT, KY.

Synopsis of bids for furnishing and setting all the stonework of superstructure, received April 10, under advertisement dated March 20, 1884.

T. J. Collins, $19,791.
J. Veihmeyer, $22,400.
J. Veihmeyer, $23,374.
Isaac Graveson & Son, $23,382.
John Boyle, $23,400.
John Boyle, $25,300.
Smith, Sargent & Co., $23,805.
Behan & McDonald, $25,547.
Behan & McDonald, $27,600.
Behan & McDonald, $28,400.
Behan & McDonald, $28,479.
Behan & McDonald, $29,870.
Behan & McDonald, $31,150.
Blatz & Krebs, $26,735.
Belknap & Dumesnil, $27,625.
W. R. & Haven, $28,200.
Hallowell Granite Company, $28,260.
M. A. McGowan, $28,390.
Wm. Graveson & Co., $30,850.
Oman & Stewart Stone Company, $32,550.

Brick Work.—Synopsis of bids for furnishing and laying all the brick work of superstructure received April 10, under advertisement dated March 20, 1884.

T. J. Collins, $8,920.
M. A. McGowan, $10,000.
Oman & Stewart Stone Company, $10,450.
W. R. & W. Haven, $10,640.
J. Veihmeyer, $10,800.
Belknap & Dumesnil, $11,000.
Smith, Sargeant & Co., $11,597.
Hallowell Granite Company, ——
Behan & McDonald, $12,250.
T. J. Kelley, $12,773.
Mason & Tudor, $15,925.

BIDS were opened for building the new insane hospitals at Evansville, Ind. and Richmond, Ind., the competition including the following propositions:

THE EVANSVILLE HOSPITAL.

Jacob Meyers & Bros., Evansville	$299,950.00
Charles Pearce & Co. Indianapolis	294,790.66
P. H. McCormick, Columbus, Ind	286,585.00
M. K. Fatout, Indianapolis	365,000.00
Peter Routier, Indianapolis	365,500.00

RICHMOND HOSPITAL.

Peter Kidder and others, Richmond	$436,750.96
M. K. Fatout, Indianapolis	439,000.00
Peter Routier, Indianapolis	441,500.06
Aaron Campfield, Winchester	299,760.92

The bids for the terra cotta were as follows: D. P. Happing, for the Richmond Asylum, $21,805.50; Indianapolis Terra Cotta Company, Richmond Asylum, $19,000 delivered; $21,000 set in position; Evansville Hospital, $22,000 delivered; $24,000 in position.

George Weaver, of this city, put in a bid of $97,260 for the brick work of the Evansville building, and $119,200 for the brick work at Richmond. The American Roofing Tile Company of Indianapolis, presented a bid of $12,872.50 for the roofing of the Richmond building, and $6,650 for that at Evansville, Ind., John G. Eigerman, of Evansville, bid $13,000 for the earthwork, brick and stonework of the Evansville Hospital.

M. E. Heirsburg, Richmond, put in several bids, irregular in form, for the slate work at Evansville, ranging from $10,830 to $11,400, according to quality of material. He also bid for the slate work at Richmond. G. Puder, of Evansville, submitted a bid for a small amount of work aggregating $1,878. According to the figures on the whole job P. H. McCormick is the lowest bidder on the Evansville work, and Aaron Campfield upon the other, but the Commissioners will not make their decision known until to-morrow. The wide difference in the bids was a subject of remark. It is claimed that the clause of the hospital act requiring bond in double the amount of the bid served to drive away many bidders. Ordinarily a bidder is required to submit a certified check in small amount, to be increased one-fourth the contract price in case he becomes the successful bidder. "The provision of the act is a slap in the face from an ethical stand-point, to contractors, and has lost many thousand dollars by driving off bidders," said one of the Commissioners.—Cincinnati *Enquirer*.